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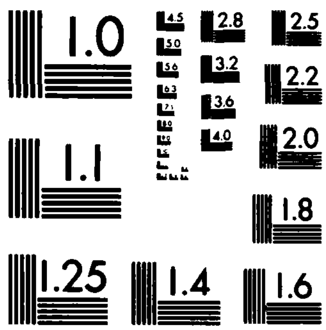

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FINAL REPORT

A BIOLOGICAL SENSITIVITY ANALYSIS OF FLEETING FOR THE PORT OF METROPOLITAN ST. LOUIS (ST. LOUIS HARBOR STUDY)

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Work Order No. 5

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A BIOLOGICAL SENSITIVITY ANALYSIS OF FLEETING FOR THE PORT OF METROPOLITAN ST. LOUIS (ST. LOUIS HARBOR STUDY)

Prepared for:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
210 Tucker Boulevard, North
St. Louis, Missouri 63101

17 July 1981

6621 ELECTRONIC DRIVE, SPRINGFIELD, VIRGINIA 22151 TELEPHONE: (703) 750-3000

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A130599	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A BIOLOGICAL SENSITIVITY ANALYSIS OF FLEETING FOR THE PORT OF METROPOLITAN ST. LOUIS (ST. LOUIS HARBOR STUDY)		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Carey W. Burch, Leslie C. Adkins, Mitzi S. Fox		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-D-0025
9. PERFORMING ORGANIZATION NAME AND ADDRESS Versar Inc. 6621 Electronic Drive Springfield, Virginia 22151		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis 210 Tucker Boulevard, North St. Louis, Missouri 63101		12. REPORT DATE 17 July 1981
		13. NUMBER OF PAGES 151
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Biological Sensitivity Analysis
Fleeting
Port of Metropolitan St. Louis
St. Louis Harbor
Barges

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this report was to provide a biological sensitivity analysis of fleeting for the Port of Metropolitan St. Louis. Conducted under the purview of the U.S. Army Corps of Engineers St. Louis Harbor Study, the area included in this evaluation was the Mississippi River and portions of its adjacent flood plain from River Miles 138.8 to 208.8.

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Final Report

A BIOLOGICAL SENSITIVITY ANALYSIS OF FLEETING
FOR THE PORT OF METROPOLITAN ST. LOUIS
(ST. LOUIS HARBOR STUDY)

Contract No. DACW43-80-D-0025
Work Order No. 5

Prepared by:

Carey W Burch

Carey W. Burch, AICP, Project Manager

Leslie C. Adkins

Mitzi S. Fox

Mitzi S. Fox

Approved by:

Donald H. Sargent
Director,
Environmental Planning Division

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1.0 EXECUTIVE SUMMARY

The purpose of this report is to provide a biological sensitivity analysis of fleeting for the Port of Metropolitan St. Louis. Conducted under the purview of the U.S. Army Corps of Engineers St. Louis Harbor Study, the area included in this evaluation was the Mississippi River and portions of its adjacent flood plain from River Miles 138.8 to 208.8

The study area was divided into 35 two-mile segments, each divided by the midchannel sailing line to form left and right bank subsegments. The biological sensitivity for each subsegment was determined by measuring seven parameters with biological significance. These parameters were aquatic habitat, shoreline terrestrial habitat, dredged material discharge, dredging frequency, barge activity, water quality, and avian population. Parameter values were converted to 1-10 scales, and then weighted according to their relative importance and sensitivity using the ranked pairwise comparison method. A high scaled value indicates a high biological value and sensitivity. The weighted values were then summed for each subsegment and placed on a final 1-10 scale for comparison purposes.

The final results of the study indicated a general trend of decreasing biological sensitivity with increasing shoreline development. However, variability between subsegments was high, with sensitivity scale values of 1-5 for subsegments with a high percentage of developed land and 5-10 for subsegments with little or no developed land. Due to the variability between measured parameters and subparameters, two subsegments may have the same sensitivity scale value and yet contain totally different combinations of biological resources. Conclusions are described in more detail in Section 5.

It should be noted that the information provided by this document is reflective of existing conditions only, and in total represents only a few of the necessary factors to be considered in making decisions relative to harbor fleeting. The information provided by this document would need to be considered in conjunction with economics, local planning and community needs, navigation, and other factors to form a comprehensive base for future planning and decision making.

2.0 INTRODUCTION

2.1 OBJECTIVES

The objective of this study was to analyze the biological sensitivity of the St. Louis Harbor area to barge fleeting in order to provide an information base for future planning and decision making. This was accomplished by analyzing selected biological resource data for subsegments of the harbor area. This limited biological evaluation will provide support for the barge fleeting investigation being conducted as part of the St. Louis Harbor Study.

2.2 BACKGROUND

The purpose of the St. Louis Harbor Study is to analyze the feasibility of providing harbor improvements in the Port of Metropolitan St. Louis. These harbor improvements include commercial terminal facilities.

The St. Louis Harbor Study evolved from two distinct Congressional Resolutions, and thus has a dual purpose. The first resolution, adopted in June 1964, authorized a study of sedimentation within the St. Louis Harbor, including a determination of the most feasible means of reducing or eliminating sedimentation. This resolution was prompted by sedimentation outside the navigation channel in local areas of a 19-mile reach of the Mississippi River, which prevented access to some docks during low flow. The harbor limits for the 1964 resolution were River Miles 172 to 191 above the mouth of the Ohio River. The second resolution, adopted in May 1971, addressed the concern of local interests that on and off loaded tonnage in the Mississippi River in the vicinity of St. Louis was not keeping pace with the increase in through tonnage. This 1971 resolution authorized a study to determine the advisibility of improving commercial harbor facilities in the vicinity of St. Louis. Subsequent to the 1971 resolution, local interests petitioned the Corps to extend the harbor study area limits to more closely define existing limits of port/harbor developments. This resulted in the extension of harbor study area limits to include both banks of the Mississippi River from River Miles 138.8 to 208.8. Appendix A contains background material on the overall St. Louis Harbor Study and information pertaining to this specific study.

2.3 LOCATION AND DESCRIPTION OF STUDY AREA

For the purpose of the present investigation, the study area is limited to the Mississippi River and a 1,000 feet (305 meters) wide strip of adjacent flood plain bordering both of the main river banks, between River Miles 138.8 and 208.8. Islands and peninsulas adjacent to the floodplain strips were included in the study area. The Mississippi River flows in a southerly direction throughout most of the 70-mile (112-km) study area and forms the general physical boundary between the States of Illinois and Missouri.

For the purpose of analysis, the 70-mile (112-km) long harbor area was divided into 35 two-mile segments. Each of these segments in turn was divided into left and right bank subsegments (study sites) separated by the midchannel sailing line. Study segments were numbered from 1 to 35 starting with the southernmost two-mile segment (River Miles 138.8 to 140.8). In addition, each subsegment was designated by the letters L or R, representing left and right bank when facing downstream. The area including the Chain of Rocks Canal and adjacent 1,000-feet (305 meters) strips of land on both banks was included as a separate study site due to its uniform appearance along its entire length and its lack of conformity with the other subsegments. The Chain of Rocks Canal is designated as segment 36. Thus, the biological sensitivity of a total of 71 subsegments was evaluated in this study. A map of the study area showing the locations of the 71 subsegments is presented as Figure 1.

The terrestrial portion of the study area includes woodlands, agricultural lands, developed lands, and wetlands. Between River Miles 165 and 208.8 (the northern portion of the study area), extensive areas of developed land occur on one or both banks of the river. Most of the shoreline is developed commercially in the vicinity of St. Louis (River Miles 176 to 184). The southern portion of the study area (River Miles 138.8 to 165) is generally less developed than the northern half. Bottomland forest occupies much of the right bank flood plain in this region; the balance is mostly agricultural. In contrast, the left bank of the Mississippi River between River Miles 138.8 and 165 is used primarily for agriculture. Mudflats, brushlands, and wetlands also occur in the study area. A flood control levee borders the Mississippi River on the left bank of much of the study area.

The aquatic portion of the study area includes the mainstem Mississippi River (including main channel and main channel border habitats), as well as adjacent portions of tributaries, backwaters, and the entire Chain of Rocks Canal. Two small aquatic areas are influenced by the tailwaters of dams (Lock and Dam 26 and Dam 27) in this 70-mile reach. The Missouri River joins the Mississippi River at Mile 195; a number of smaller tributaries also occur in the study area.

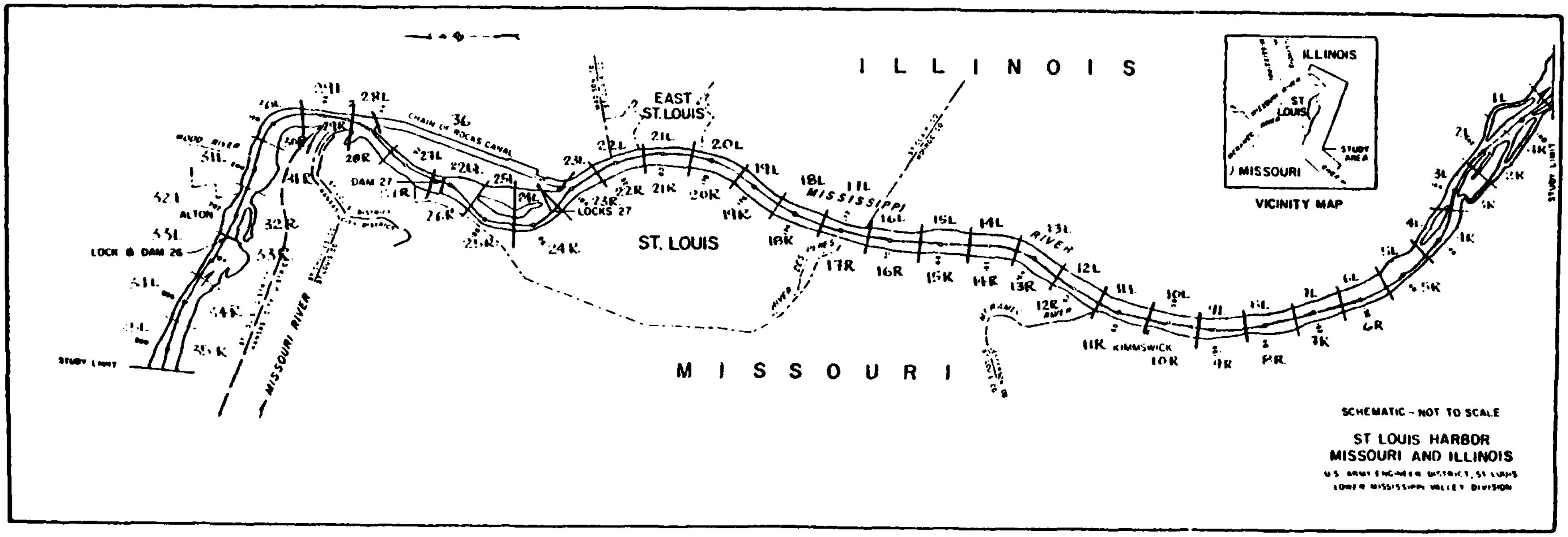

Figure 1. MAP OF STUDY AREA SHOWING LOCATIONS OF TWO-MILE SEGMENTS

2.4 COORDINATION ACTIVITIES

An initial scoping meeting was held on 28 August 1979 by the St. Louis Corps of Engineers in order to determine the level of effort required for the St. Louis Harbor Study and to introduce interested federal and state agencies to the program. Based on the guidance resulting from this meeting, a District Study Proposal, dated 14 September 1979, was formulated by the Corps.

Subsequent to this initial effort, a letter was sent to the participating agencies requesting written comments or questions involving the study. A copy of this correspondence and a listing of involved agencies is presented in Appendix B. Copies of comments received from the agencies are also included. Four of the agencies, the U.S. Army Corps of Engineers, St. Louis, the U.S. Fish and Wildlife Service (FWS), the Illinois Department of Conservation (IDOC), and the Missouri Department of Conservation (MDOC), were involved in providing input for the determination of the parameter weights.

A draft report was sent to the involved agencies on 17 April 1981 for their review. On 24 June 1981, a scoping meeting was held at the St. Louis Headquarters of the Corps to discuss the draft report. A list of meeting participants is presented in Appendix B. Following the meeting, a letter was sent to all participants summarizing the changes agreed upon for incorporation into the final report. A copy of the letter is included in Appendix B. A copy of a document letter from Missouri Highway and Transportation Department is also included.

After submittal of the final report to all the coordinating agencies, review comments will be solicited through letter.

3.0 METHODS

The analytical methods used in this study were derived from an environmental evaluation system developed by Battelle-Columbus for the Bureau of Reclamation, U.S. Department of the Interior (Dee et al., 1972). The methodology has been modified to fit the specific needs of this study. In this approach, the biological sensitivity of a river segment to potential fleeting was quantitatively determined by first measuring a number of parameters that have biological significance. Measured parameter values were converted to 1-10 scale values and then multiplied by their respective parameter weights, which were previously determined using a ranked pairwise comparison technique. The sum of the products of scaled parameters and respective parameter weights provides a value which indicates the biological sensitivity of a subsegment relative to other subsegments.

In this analysis, seven parameters indicative of biological sensitivity were selected and measured for each of the 71 subsegments. Aquatic habitat, shoreline terrestrial habitat, avian populations, dredged material discharge, dredging frequency, barge activity, and water quality were the chosen parameters. Three of the parameters are composites consisting of several subparameters; aquatic habitat has five subparameters, shoreline terrestrial habitat has four subparameters, and avian population has three subparameters.

The parameter values were converted to 1-10 scale values based on biological sensitivity, with the high portion of the scales corresponding to a high level of sensitivity. The scales were reversed for the "negative" parameters. Aquatic habitat, shoreline terrestrial habitat, and avian population were all positive biological parameters, and on scales where 10 corresponds to a high parameter value (e.g., high biological value). Dredged material discharge, dredging frequency, barge activity, and water quality were all negative aspects of a site's biological sensitivity; thus they were on scales where 1 corresponds to a high parameter value, indicating adverse biological conditions.

Scaled parameter values were then multiplied by their respective parameter weights, and summed for each subsegment. High values indicated relatively high biological sensitivity. The parameter weights used were the arithmetic mean of four sets of weighting factors, each independently derived. Contributing a set of parameter weights were the U.S. Army Corps of Engineers, St. Louis, the U.S. Fish and Wildlife Service (FWS), and the Illinois and Missouri Departments of Conservation (IDOC and MDOC, respectively). Weighting of the various parameters and subparameters by each agency was done according to the ranked pairwise comparison technique.

This approach provided a systematic means of assessing and comparing the biological sensitivity of a large number of subsegments; it was not designed to provide an in-depth analysis of habitat or potential for environmental degradation at each subsegment. The purpose of the study is to enable the identification of those subsegments which, when compared to the others by the chosen parameters, are least likely to be biologically sensitive to the potential impacts of barge fleeting. A detailed discussion of the methodology is presented in the following sections.

3.1 DETERMINATION OF PARAMETER WEIGHTS

Parameter weights were determined by each participating agency, using a ranked pairwise comparison technique, whereby importance values are assigned to each parameter. First, each parameter was compared to all others with regard to relative importance. The criteria for determining relative importance were a parameter's biological value and its sensitivity to the impacts of barge fleeting. In each pairwise comparison the parameter perceived to be the most important biologically was assigned a value of 1.0, and the least important parameter was assigned a value of 0.0. If both of the parameters were considered equivalent in biological importance, 0.5 was assigned to each. Some of the agencies involved used other comparisons, such as 60:40, 75:25, etc. A dummy variable was used to ensure that no factor be given a total value of 0. The values for each parameter were then summed and divided by the grand total of all the comparisons; the resulting sum represented the parameter weight. By this procedure a weight was calculated for each of the seven parameters used.

In addition to parameter weights, subparameter weights were determined for the composite parameters (e.g., aquatic habitat, shoreline terrestrial habitat, and avian populations). Subparameter weights were calculated in the same manner as parameter weights, using the ranked pairwise comparison technique.

The final values used for parameter and subparameter weights in this analysis were the arithmetic means of the individual weights contributed by the agencies involved (i.e., Corps, FWS, IDOC, MDOC). In addition to the parameter weights, each agency provided a written explanation of the criteria used in assigning relative biological importance values.

3.2 HABITAT CLASSIFICATION

Information on the aquatic and terrestrial habitat parameters was obtained from the following sources: 1:24,000-scale black-and-white and color aerial photos taken in October 1979; enlarged

1974 black-and-white aerial mosaics; 1974 color infrared aerial photos; hydrographic survey maps (COE, 1978B and 1978C); navigation charts (COE, 1978d); and 1:24,000-scale project base maps. The midchannel sailing line was determined using the navigation charts. Aquatic areas were classified as main channel, main channel border, backwater, tailwater, or tributary. These classifications were the subparameters used for aquatic habitat. The criteria used for the aquatic habitat classification are given in Appendix C. Main channel boundaries were determined using the hydrographic maps. The normal stage bankline forming the landward boundary of the main channel border was estimated by averaging the banklines shown in 1974 aerial photos (depicting a high water stage) and 1979 aerial photos (depicting a low water stage). The 1979 aerial photos were used for delineating other aquatic habitats.

Terrestrial areas were classified as forested lands, open lands, developed lands, or wetlands according to the criteria given in Appendix C, primarily using the October 1979 aerial photos. These habitat classifications were used as the shoreline terrestrial habitat subparameters in later analysis.

A series of 1:24,000-scale black-and-white aerial photos was prepared for the purpose of this report. Site boundaries and delineation of aquatic and shoreline terrestrial habitat types are shown on these photos, which are presented in a separate portfolio.

3.3 GENERAL PARAMETER ANALYSIS

A description of the procedures used to measure each parameter and subparameter is provided in this section. The rationale for the selection of the various parameters is discussed in Section 3.4. In general, the parameters that were selected were indicative of existing biological resources and/or sensitivity of a subsegment to barge fleeting.

3.3.1 Aquatic Habitat

The aquatic habitat value for each subsegment is the sum of the five weighted aquatic habitat subparameter ratings. The unweighted subparameter ratings were obtained by dividing the area of a given aquatic habitat classification by the total aquatic area of a subsegment. A planimeter was used to measure the area of each aquatic habitat classification at each subsegment, using the prepared black-and-white photos. The product of subparameter weights and the unweighted subparameter ratings became the weighted subparameter ratings. Finally, the weighted ratings for main channel, main channel border, backwater, tributary, and tailwater were summed to obtain the aquatic habitat value for each subsegment. The computation sheet used in determining the aquatic habitat value is presented as Form A in Appendix D.

3.3.2 Shoreline Terrestrial Habitat

The shoreline terrestrial habitat value for each subsegment was computed in the same manner as the aquatic habitat value (Section 3.3.1). As with the aquatic habitat determination, the areal extent of each terrestrial habitat classification on the 1979 1:24,000-scale black-and-white photos was measured with a planimeter. The four habitat classifications (subparameters) were developed lands, forested lands, open lands, and wetlands. Shoreline terrestrial habitat extended shoreward 1,000 feet (305 meters) from the estimated riverbank line. Islands in the river were included as part of the shoreline terrestrial habitat. The sum of the weighted ratings for these subparameters is the terrestrial habitat value for each subsegment. The computation sheet used in determining the shoreline terrestrial habitat value is presented as Form B in Appendix D.

3.3.3 Avian Population

The avian population value for each subsegment was calculated as the sum of weighted 1-10 scale values given to the subparameters of waterfowl, eagles, and herons. Subparameter weights were determined as described in Section 3.1. The unweighted (scaled) ratings for the avian population subparameters were determined as follows:

Waterfowl. For each harbor reach flown during the Illinois Natural History Survey's Waterfowl Census (1973-1979), a calculation was first made of the total birds counted per river mile. River reaches flown by the survey that are totally or partially within the harbor include Grafton, (River Mile 2.9) to Alton (River Mile 202), St. Louis (River Mile 180) to Kimswick (River Mile 159) to Crystal City (River Mile 149), and Crystal City (River Mile 149) to Ste. Genevieve (River Mile 124). Within the reach between Alton (River Mile 202) and St. Louis (River Miles 180) waterfowl apparently depart from this developed segment of river in preference for the Horseshoe Lake region. For the purpose of this present evaluation, the bird counts per mile for this reach were assumed to be zero.

A problem encountered during an initial tabulation was the fact that the single reach of river flown above Lock and Dam 26 was not always flown at the same time as the harbor reaches below the dam. In order to make the data more comparable, tabulation was restricted to flight periods that were similar for all reaches.

Next the average waterfowl counts per river mile were plotted on a graph at the midpoint of each reach. Lines connecting the midpoint values were then placed on the graph and the resulting product visually adjusted to provide a smoother curve. The range of graph values were then divided by 10. Using this graph, 1-10 scale values were then determined for each subsegment.

Eagles. Eagle counts were also made during the Illinois Natural History Survey's Waterfowl Census. Scaled values were derived for this parameter using a procedure similar to that utilized for the Waterfowl Census.

Since the Natural History Survey did not fly the river between St. Louis and Alton, a value of zero counts per mile was assigned to this reach. It should be noted that while eagle usage of this reach is known to be quite low, it is not actually zero. A smoothed curve was used to remove some of this zero value distortion.

Herons. The approach taken to this parameter was to assign a rating of 10 to any harbor subsegment adjacent to a heron nesting site (presently active or recently active); all other areas would be rated 1.

The computation sheet for determining the avian population value is presented as Form C in Appendix D. For each subsegment, the scaled values for waterfowl, eagles, and herons (the unweighted subparameter ratings) were multiplied by their respective subparameter weights to give the weighted subparameter ratings. The sum of the weighted ratings for waterfowl, eagles, and herons gave the avian population value for each subsegment.

3.3.4 Dredged Material Discharge

The dredged material discharge value was expressed as the volume of dredged material discharged over the past nine years divided by the total aquatic area of the subsegment. Dredged material discharges (volume and location) were supplied by the Corps.

3.5.5 Dredging Frequency

The dredging frequency value was expressed as the number of dredgings (and thus dredged material discharges) occurring during the past nine years divided by the total aquatic area of each subsegment. Dredging counts and areas of occurrence were supplied by the Corps.

3.5.6 Barge Activity

The barge activity value for each subsegment was expressed as the average number of barges observed on aerial photographs for five different flight dates (August 1975, December 1976, December 1977, October 1979, and July 1980) divided by the total aquatic acreage of the subsegment. All barges visible in the photos were counted. The average number of barges per subsegment was supplied by the Corps.

3.3.7 Water Quality

The water quality value was determined as the total number of point source discharges (including wastewater and refuse disposals) divided by the total aquatic acreage of the subsegment. For the purpose of this analysis, tributary creeks and rivers draining urban areas that empty directly into the Mississippi River were considered to be point source discharges.

The discharge information was derived from data compiled from the Corps' permit inspection program. Data sources for the inspection program include Corps and NPDES permits. Spill data obtained from the U.S. Coast Guard for the year 1980 was used to adjust water quality values downward for 8 river subsegments. These subsegments accounted for 80 percent of the approximately 140 spills (mostly petroleum spills) recorded by the Coast Guard within the study area. Data on number of point source discharges and occurrence of harbor spills were supplied by the Corps.

3.4 BIOLOGICAL SENSITIVITY ANALYSIS AND RANKING

The biological sensitivity analysis and final ranking of the 71 subsegments were completed in the following manner. The weighted ratings for each of the seven parameters were summed to give the biological sensitivity value. In order to facilitate the final comparison of subsegments, the biological sensitivity values were converted to 1-10 scale values, where high-scaled values represent high biological sensitivity. The 1-10 scales for the aquatic habitat, shoreline terrestrial habitat, and avian population parameters were derived by dividing the range of parameter values into 10 equal intervals. Scales for dredged material discharge, dredging frequency, barge activity, and water quality were adjusted to allow for several skewed data points. The adjustments consisted of placing a scale value of 10 for a 0 data point and leaving the scale value of 1 open-ended to encompass the skewed data points. The computation form used in the final biological sensitivity analysis is given in Appendix D as Form D.

3.5 RATIONALE FOR PARAMETER SELECTION

In general, parameters were selected that would measure a subsegment's biological importance and sensitivity, combining inherent biological value with the subsegment's sensitivity to the impacts of barge fleeting. However, there are scarce data available on the impacts of barge fleeting specifically. Therefore, conclusions as to potential adverse impacts were based on the known impacts resulting from barge activity in general. Each parameter measured is discussed below.

3.5.1 Aquatic Habitat

There is considerable evidence that the aquatic habitat can be affected, both directly and indirectly, by activities associated with barges and towboats. Different components of the aquatic environment are expected to be differentially sensitive to the effects of barge activity. The aquatic habitat classifications (subparameters) selected for this study reflect perceived differences in biological value and biological impact sensitivity; main channel, main channel border, backwater, tailwater, and tributary areas are expected to be differentially sensitive to barge activity because of their varying biological, physical, and chemical properties.

It is generally accepted that the main channel of the Mississippi River in the study area is the least productive of the aquatic habitats, mainly because of strong currents, high turbidity, and unstable bottom substrate (COE, 1975). Studies show that there is sometimes an observable turbidity trail for several miles behind towboats, resulting from the marginal clearance between loaded barges or towboats and the channel bottom during periods of low water (Sparks, 1975). Increasing turbidity and concentrations of pollutants through resuspension of river bottom sediments may further interfere with plant and animal life.

Main channel border areas are considered valuable fish habitats. These areas are generally more productive and support a more diverse flora and fauna than main channel areas (COE, 1975). Channel border habitat is considered to be an important spawning area, nursery, and feeding ground for fish. This habitat is already affected by activities of tow traffic and while fleeting would most likely generate similar effects, it would represent an intensification of these impacts for the main channel border area (where most fleeting occurs). The following paragraph describes the perceived impacts of barge fleeting.

Propellor wash from passage of tows in the main channel can cause resuspension of fine material from the bottom and sides of the main channel, increasing turbidity and possibly reducing primary productivity. High concentrations of suspended solids may also alter the faunal composition, density, and the species diversity of macroinvertebrates. Barge activity may also cause resuspension of organic toxicants through the resuspension of sediments. In addition, sediments may interfere with fish reproduction. Wave and propellor action may be a primary erosion factor along unreveted shoreline. Propellor action can potentially damage or uproot vegetation; mosses, liverworts, and shallow-rooted herbaceous plants that occur in the wave wash zone may be adversely affected (COE, 1975). In addition, a number of shore-dwelling animals such as muskrat (*Ondatra zibethica*) and beaver (*Castor canadensis*), especially the young in bank dens, may be adversely affected by wave and propellor wash. Amphibians and

reptiles that use the shoreline for breeding could suffer nest destruction. The reduction of shoreline aquatic vegetation could cause a significant reduction in food sources and shelter for terrestrial vertebrates. Moreover, noises and other disturbances caused by fleeting represent a relatively unstudied but potentially disruptive factor for shore-dwelling animals (Newling, 1975).

Backwater areas, including side channels, are generally more productive than either main channel or channel border habitat. The species diversity and density of aquatic macrophytes, phytoplankton, zooplankton, benthic fauna, and fish are usually higher in backwaters than in any other aquatic habitats in the study area (COE, 1975). Backwaters provide cover for fish and are important nursery and spawning grounds. This habitat also supports a great variety of reptiles and amphibians, several species of fur-bearing mammals, resident wading birds, and migrating waterfowl. The impacts of fleeting on backwater habitats are generally expected to be similar to that for the main channel border habitats, but on a lesser scale due to the increased distances from the source of the disturbance. As evidenced by through traffic, towboats have been shown to be capable of altering the rate and direction of flow in side channels as they pass, and a rise and fall in water level occurs (Sparks, 1975). In addition, barge activities in the main channel may enhance the transport of sediments into backwaters (COE, 1975). Backwaters, including side channels, are especially vulnerable to siltation because suspended materials settle in the reduced current. Increased turbidity and sedimentation could cause a reduction in the productivity of backwaters.

Tailwaters are disturbed areas which often provide a good fishery resource due to high population densities created by the dam, which serves as a barrier to upstream movement. The turbulence from the passage of water through the dam generally prevents aquatic macrophytes from taking root. Tailwaters may, at times, function as winter feeding grounds for eagles. Tailwaters are not normally used for barge fleeting purposes and are thus not likely to experience significant direct impacts. However, it can be assumed that the tailwater areas will experience some indirect effects similar to those already discussed, although the impacts will be modified by the ambient turbulence.

The tributaries in the study area provide a diverse aquatic habitat, as most tributaries contain their own main channel, channel border, and backwater areas. In the relatively unpolluted tributaries there is the potential for a high species diversity of fish, wildlife, and benthic fauna (COE, 1975). For the most part, the strong current prevents the growth of emergent or floating vegetation (Newling, 1975). Amphibians and reptiles use tributaries to a lesser extent than backwaters because of the strong currents. It is expected that the fauna and flora of tributaries would be less sensitive to the effects of Mississippi River fleeting than the biota of the other aquatic habitats since the strong currents of these tributaries would shield them somewhat from the wave and propellor wash, turbulence, and turbidity.

In addition to the abovementioned effects, chemical pollution associated with fleeting may be an additional source of stress on the aquatic environment. Pollution from accidental discharge of sanitary and kitchen wastes, spillage of cargo, or barge washing has the potential to directly impact main channel, main channel border, backwater, and tailwater habitats. Spills of toxic chemicals, such as petroleum products, can have serious impacts on organisms at all levels of the food chain. Light oils are highly poisonous to fish, shellfish, benthos, and other organisms when emulsified in water. Birds and mammals that feed on contaminated aquatic organisms may also be poisoned. Furthermore, heavier weight oils may cover reptiles, birds, and mammals, as well as their habitats.

3.5.2 Shoreline Terrestrial Habitat

The shoreline terrestrial habitat classifications (subparameters) used in this study were forested lands, open lands, developed lands, and wetlands. These habitats differ in their species diversity and productivity, and probably also differ in sensitivity to barge fleeting. However, little specific information is available on the effects of fleeting on terrestrial flora and fauna, and the following discussion is based on scientific judgement.

The forest habitat category supports a diverse assemblage of plant and animal species. Bottomland forest can provide spawning and feeding for certain fish species when inundated. Mast-producing trees have high food value and trees provide nests and dens for a variety of bird and mammal species (COE, 1975). Where this habitat interfaces with the channel border, increased wave wash associated with fleeting activities could adversely affect plants and animals, as discussed in Section 3.5.1. It is also possible that noise from barge fleeting could disturb populations of some sensitive animal species, as discussed in the upcoming Section 3.5.3. Furthermore, fleeting may indirectly impact forested lands by increasing the potential for commercial development of property. The selection and development of a new fleeting site may stimulate new commercial development or the expansion of existing development to accomodate the increased barge activity.

Lands classified as open in this study are used primarily for agricultural purposes, although some old field habitat is also represented in the study area. Corn, soybeans, and wheat are the predominant crops in the cultivated fields, which have little wildlife value (Newling, 1975). However, migrating waterfowl graze in wheatfields and utilize unharvested crops, and amphibians and turtles sometimes frequent these areas. In addition, fencerows provide food and shelter for some birds and mammals. Old fields and some pasture can support a diverse assemblage of birds and rodents, which in turn provide food for

raptors and other predators. Open areas are probably less sensitive to fleeting activities than bottomland forest and wetlands. However, fleeting may indirectly result in the commercial development of some agricultural area through the expansion or creation of commercial facilities in conjunction with the increased fleeting.

Wetlands in the study area are highly productive. Along with the aquatic organisms this habitat supports a significant part of the waterfowl migration in the Mississippi Flyway, as well as resident wading birds, reptiles, fur-bearing mammals, and amphibians (COE, 1975). It is expected that the sensitivity of this habitat to fleeting is dependent on the representation of animals that are disturbed by noise and other human activity. During periods of high waters, wetland plants and animals could also be affected by spills of toxic chemicals associated with fleeting. Wetlands may also be indirectly impacted by fleeting through increased potential for shoreline development.

Developed lands generally support only wildlife and plants that are tolerant of human disturbance. Animals such as little brown bat (*Myotis lucifagus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), and some snakes and birds can be found in these areas (COE, 1975). Fleeting will probably not affect the biological resources in this habitat.

3.5.3 Avian Population

A composite parameter representing avian populations was included in this analysis because there is some evidence that barge activities may adversely affect some important bird species. The main avian population value was calculated from three subparameters: waterfowl, eagles, and herons.

A waterfowl count was selected as a subparameter because numerous migrating and resident waterfowl, including dabbling ducks, diving ducks, mergansers, coots, geese, and shorebirds, occur in the vicinity of the study area. The impact of fleeting on waterfowl is an important consideration because adequate feeding and resting areas are critical for some migrating avian species. For example, an estimated 10,000 to 12,000 canvasback ducks (*Aythya valisineria*) winter in Pool 26 (COE, 1975). These diving ducks, which rest and feed in open water, fly directly to the Chesapeake Bay or farther south after leaving their staging areas on the Mississippi River. If this flight is undertaken when the birds are not rested and with low energy reserves, the increased stress causes them to spend additional time on their wintering grounds (Newling, 1975). Barge movements through resting and feeding rafts of wild ducks disturbs the ducks and may force them off preferred areas. Furthermore, barge activity may adversely affect clams, the major food source for diving ducks. The study area is also an important breeding ground for

wood ducks (Aix sponsa) and wintering ground for mallards (Anas platyrynchos) and other dabbling ducks (COE, 1975). Because the dabbling ducks are adapted to a greater variety of habitats than the diving ducks, they are probably less sensitive to fleeting activities than diving ducks. Potential petroleum spills associated with barge activities and transfer operations could kill waterfowl by direct poisoning, by coating their bodies, or by reducing important food sources.

An eagle count was included as part of the avian population parameter because the bald eagle (Haliaeetus leucocephalus) is known to winter along the Mississippi River in the vicinity of the study area. In fact, the States of Illinois and Missouri host one of the largest concentrations of wintering eagles in the United States (Spencer, 1976). This species is usually associated with lakes and backwater areas away from the main river, however, and the effect of barge activities on the normal roosting and feeding patterns is not known (COE, 1975). Nevertheless, human activities are known to disturb feeding eagles, and spills of toxic chemicals could harm eagles by disturbing the food chain (Stalmaster and Newman, 1978). Roosting areas disturbed by fleeting would not necessarily cause eagles to leave the area; Snow (1973) reported that eagles can establish new roosting locations, which are not always near feeding areas. Bald eagles are listed as endangered over most of their range by the Office of Endangered Species, U.S. Fish and Wildlife Service, under the Endangered Species Act of 1973.

The heron colony count was used as an avian population subparameter because great blue heron (Ardea herodias), great egret (Casmerodius albus), cattle egret (Bubulcus ibis), little blue heron (Egretta caerulea), and black-crowned night heron (Nyctiorax nyctiorax) may inhabit the Mississippi River and flood plain in the vicinity of the study area and may be sensitive to fleeting activities (COE, 1975). Moreover, the latter two species are classified as endangered by the State of Illinois (IDOC, 1979). The Illinois Natural History Survey and the Waterways Experiment Station (WES) have reported decreasing trends in heron populations in the Middle and Upper Mississippi River in the past decade (Grabber, 1977; Thompson and Landin, 1978). In fact, no heron colonies have been reported in the project area since 1977. Heron populations undergo natural fluctuation, however, and the reason for the recent decline is not known. According to WES, human activities (including barge operations) are avoided by herons and egrets. Furthermore, there is some evidence that colonies of herons, which usually nest in forested areas, require considerable seclusion and quiet (COE, 1975). The noise and activities associated with fleeting could have a deleterious impact on nesting colonies of herons in the study area.

3.5.4 Dredged Material Discharge

A measure of dredged material discharge was included as a parameter because it is generally accepted that dredging and disposal of dredged material have adverse effects on the aquatic environment. Other factors equal, areas that have been dredged extensively are expected to be less biologically sensitive to the effects of fleeting than areas that have not been dredged. Dredging causes a temporary increase in turbidity, resuspension of pollutants, and destruction of some benthic organisms. One study of benthic fauna in the Mississippi River reported a lower species diversity of benthos in both dredged and disposal areas than in border areas (COE, 1975). Disposal of dredged material may smother beds of vegetaticn and benthic organisms, and dredged material may be carried by water currents to new locations. Other results of dredging and/or disposal of dredged material include alterations in water quality, water depth, substrate, and shore location (COE, 1979). In using dredging volume as the measure of dredged material discharge, it was assumed that the magnitude of biological impacts of dredging is related to the amount of material dredged.

3.5.5 Dredging Frequency

A parameter representing dredging frequency was used because the abovementioned effects of dredging and dredged material disposal are expected to impact the aquatic environment most severely if an area is dredged often, resulting in frequent discharges of dredged material. Chronic disturbance of an aquatic habitat may prevent plant and animal populations from becoming re-established in dredged or disposal areas; these areas may be less sensitive to the effects of fleeting than areas that have not been dredged frequently.

3.5.6 Barge Activity

As discussed in other sections of this report, the barge activities associated with fleeting may adversely affect the biota of the aquatic and shoreline terrestrial environments. A parameter representing present and recent barge activity in the study area was selected under the assumption that the biological environment of areas that already experience barge activity may be less sensitive to fleeting impacts than the environment of the less disturbed river segments. River reaches with considerable barge activity are expected to experience more turbidity, wave wash, drawdowns, noise, disturbance, and pollution than are less utilized river segments.

3.5.7 Water Quality

A parameter representing water quality was included in this analysis because water quality degradation results in disturbance of the aquatic environment, as indicated by a general decrease in species diversity and productivity in polluted areas. A Corps study indicated that the Mississippi River in the vicinity of St. Louis is characterized by high BOD, and high concentrations of nutrients, total suspended solids, and coliform bacteria. A water resources study conducted by the St. Louis Corps revealed that, in general, local waste discharges do not significantly pollute the Mississippi River in the St. Louis area because of the large dilution ratio. It should be noted that the large dilution factor does not solve the problems inherent in waste discharges; it merely masks them. In specific areas water pollution may be a significant problem. Near outfalls, BOD, coliform, temperature, and other parameters may be high because of incomplete mixing; in these localized areas the biota may be affected. In selecting the number of point source discharges as a measure of water quality, it was assumed that areas locally degraded by outfalls will be less biologically sensitive to fleeting impacts than unpolluted areas. Since harbor spills may adversely affect the local biota, the water quality ratings of sites frequently impacted by such spills were modified as described in Section 3.5.1.

4.0 RESULTS

4.1 PARAMETER WEIGHTS

The parameter and subparameter weights used in establishing the relative importance of the parameters are the arithmetic mean of four sets of parameter weights supplied by the Corps, FWS, IDOC, and MDOC. Tables 1 through 3 show the subparameter weights supplied by the agencies for aquatic habitat, shoreline terrestrial habitat, and avian populations. Table 4 contains the parameter weights for the biological analysis parameters. The computation sheets used for each agency's derivation of subparameter and parameter weights as determined by the ranked pairwise comparison technique, as well as the rationale used by each agency in determining the weights, are contained in Appendix E.

4.2 RESULTS OF PARAMETER EVALUATIONS

4.2.1 Unweighted Ratings for Aquatic and Shoreline Terrestrial Habitat Subparameters

Black-and-white aerial photos (1:24,000) delineating the classification of habitat by subparameters are presented in a separate portfolio. Using these photos, the areas of each subparameter type were measured for each subsegment with a planimeter. The results are contained in Appendix F. The habitat subparameter areas for each subsegment were summed to obtain total terrestrial and aquatic areas for that subsegment. The subparameter areas were then divided by the total area and multiplied by 100 to obtain an unweighted rating for the subparameters. For example, the area in forested lands (a shoreline terrestrial habitat subparameter) in Subsegment 1 was divided by the total terrestrial area of Subsegment 1 and multiplied by 100 to establish the unweighted rating for forested lands. Unweighted ratings for aquatic habitat subparameters are given in Table 5. Table 6 contains the unweighted ratings of the shoreline terrestrial habitat subparameters.

4.2.2 Weighted Ratings for Aquatic and Shoreline Terrestrial Habitat Subparameters

The unweighted ratings for aquatic habitat subparameters in Table 5 were multiplied by their respective subparameter weights to determine their weighted ratings, which are given in Table 7. The sum of the aquatic subparameter weighted ratings for each subsegment becomes the subsegment's aquatic habitat value. The shoreline terrestrial habitat values were derived the same way. Table 8 shows the shoreline terrestrial habitat subparameter weighted ratings and their sum for each subsegment.

Table 1. ASSIGNMENT OF AQUATIC HABITAT SUBPARAMETER WEIGHTS

Subparameter	CORPS	FWS	MDOC	IDOC	Average
Main Channel	.07	.07	.06	.10	.08
Main Channel Border	.33	.16	.17	.26	.23
Backwaters	.27	.27	.30	.27	.28
Tributaries	.20	.30	.25	.27	.25
Tailwaters	.13	.20	.22	.10	.16

Table 2. ASSIGNMENT OF SHORELINE TERRESTRIAL HABITAT SUBPARAMETER WEIGHTS

Subparameter	CORPS	FWS	MDOC	IDOC	Average
Forested Lands	.40	.30	.24	.28	.30
Open Lands	.20	.25	.29	.27	.25
Developed Lands	.10	.10	.10	.10	.10
Wetlands	.30	.35	.37	.35	.35

Table 3. ASSIGNMENT OF AVIAN POPULATION SUBPARAMETER WEIGHTS

Subparameter	CORPS	FWS	MDOC	IDOC	Average
Waterfowl	.33	.33	.37	.29	.33
Eagles	.34	.42	.33	.42	.37
Herons	.33	.25	.30	.29	.30

Table 4. ASSIGNMENT OF BIOLOGICAL ANALYSIS PARAMETER WEIGHTS

Parameter	CORPS	FWS	MDOC	IDOC	Average
Aquatic Habitat	.25	.20	.20	.20	.21
Shoreline Terrestrial Habitat	.22	.14	.20	.19	.19
Dredged Material Discharge	.05	.14	.06	.07	.08
Dredging Frequency	.05	.09	.06	.07	.07
Barge Activity	.16	.10	.09	.07	.10
Water Quality	.16	.16	.21	.20	.18
Avian Populations	.11	.17	.18	.20	.17

Table 5. AQUATIC HABITAT SUBPARAMETER UNWEIGHTED RATINGS

	Main Channel		Main Channel Border		Backwater		Tributary		Tailwater	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	47.2	76.4	51.1	18.5	1.7	0	0	5.1	0	0
2	62.9	67.0	36.3	28.2	0.8	4.6	0	0.2	0	0
3	44.8	47.5	55.2	52.5	0	0	0	0	0	0
4	40.7	83.6	58.5	16.4	0.8	0	0	0	0	0
5	57.9	60.7	36.5	34.6	5.7	0	0	4.7	0	0
6	40.2	49.5	56.7	50.5	3.1	0	0	0	0	0
7	25.7	82.3	74.3	17.1	0	0	0	0.6	0	0
8	54.2	58.2	45.8	41.8	0	0	0	0	0	0
9	24.6	79.4	74.6	20.6	0.4	0	0.4	0	0	0
10	53.8	27.1	46.2	72.9	0	0	0	0	0	0
11	25.9	74.6	74.1	25.4	0	0	0	0	0	0
12	13.7	81.7	86.3	14.5	0	0	0	3.8	0	0
13	67.6	34.6	32.4	64.0	0	1.4	0	0	0	0
14	56.7	45.4	43.3	54.6	0	0	0	0	0	0
15	32.7	56.5	67.3	43.5	0	0	0	0	0	0
16	8.5	75.8	91.5	24.2	0	0	0	0	0	0
17	85.1	48.1	14.9	50.8	0	1.1	0	0	0	0
18	12.0	78.6	88.0	21.4	0	0	0	0	0	0
19	39.1	46.6	60.9	53.4	0	0	0	0	0	0
20	55.5	71.9	44.5	28.1	0	0	0	0	0	0
21	72.2	41.5	27.8	58.5	0	0	0	0	0	0
22	38.3	8.5	61.7	91.5	0	0	0	0	0	0
23	28.3	35.0	71.7	65.0	0	0	0	0	0	0
24	7.6	41.1	92.4	58.9	0	0	0	0	0	0
25	7.3	24.7	92.7	75.3	0	0	0	0	0	0
26	19.0	2.8	60.2	68.5	0.3	0	0	0	20.5	28.7
27	0.7	29.2	99.3	70.8	0	0	0	0	0	0
28	87.0	43.5	13.0	47.0	0	9.5	0	0	0	0
29	73.1	27.3	25.9	56.2	0	4.7	1.0	11.8	0	0
30	35.2	26.0	8.1	62.8	6.7	11.2	0	0	0	0
31	39.9	53.3	8.7	17.4	0	29.2	1.4	0	0	0
32	59.6	41.5	31.3	26.4	0	0	0	0	9.1	32.1
33	99.0	54.4	1.0	40.9	0	0.9	0	0	0	3.8
34	95.5	43.8	4.5	32.9	0	23.3	0	0	0	0
35	57.5	41.9	42.5	33.3	0	24.8	0	0	0	0
36 Chain of Rocks	100.0		0		0		0		0	
SUBPARAMETER WEIGHTS	0.08		0.23		0.28		0.25		0.16	

Table 6. SHORELINE TERRESTRIAL HABITAT SUBPARAMETER UNWEIGHTED RATINGS

	Forested Land		Open Land		Developed Land		Wetlands	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	77.6	31.8	22.4	30.0	0	23.3	0	14.9
2	79.6	91.7	13.9	8.3	6.5	0	0	0
3	80.4	63.7	10.2	36.3	9.4	0	0	0
4	89.8	83.3	5.3	4.7	4.5	12.0	0	0
5	66.7	89.2	33.3	9.0	0	0	0	1.8
6	75.0	89.3	24.4	0	0	7.5	0.6	3.2
7	92.6	61.4	3.4	8.3	0	30.3	4.0	0
8	47.1	90.8	52.9	4.9	0	4.3	0	0
9	91.3	93.0	7.7	0	0	7.0	1.0	0
10	57.6	69.8	40.3	17.9	0	12.3	2.1	0
11	90.8	65.5	9.2	31.0	0	3.5	0	0
12	68.1	70.9	31.9	8.0	0	21.1	0	0
13	40.6	88.3	59.4	0.8	0	10.5	0	0.4
14	31.9	59.9	62.3	40.1	5.8	0	0	0
15	72.1	29.8	24.7	8.6	3.2	61.6	0	0
16	41.3	46.0	57.6	19.3	1.1	34.7	0	0
17	21.6	11.3	78.4	1.3	0	87.4	0	0
18	26.0	0	74.0	0	0	100.0	0	0
19	41.1	0	35.0	0	23.9	100.0	0	0
20	11.3	0	0	0	88.5	100.0	0.2	0
21	2.8	0	6.8	0	90.4	100.0	0	0
22	4.7	0	13.5	0	81.8	100.0	0	0
23	53.4	9.4	29.0	0	17.6	90.6	0	0
24	80.6	16.8	12.8	11.8	0	71.4	6.6	0
25	78.3	22.7	18.3	53.6	0	23.7	3.4	0
26	36.3	20.9	63.2	26.6	0	46.3	0.5	5.7
27	33.1	24.6	66.1	69.1	0.8	6.3	0	0
28	77.6	44.6	15.9	37.7	3.3	0	3.3	17.7
29	34.7	31.6	46.0	45.8	12.5	1.8	6.8	20.8
30	25.0	41.6	14.4	58.4	59.1	0	1.5	0
31	30.1	64.8	9.6	27.7	61.3	0	0	7.5
32	25.1	50.7	.6	24.9	74.3	12.6	0	12.3
33	33.9	24.2	0	19.0	66.1	11.9	0	45.0
34	32.2	46.9	13.0	19.3	4.3	6.9	.5	26.4
35	60.7	69.3	7.4	6.9	14.7	0	17.2	23.8
36 Chain of Rocks	3.2		31.3		59.4		0.6	
SUBPARAMETER WEIGHTS	0.30		0.25		0.10		0.35	

Table 7. AQUATIC HABITAT SUBPARAMETER WEIGHTED RATINGS

	Main Channel		Main Channel Border		Backwater		Tributary		Tailwater		Aquatic Habitat Value	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	3.78	6.11	11.75	4.26	0.48	0	0	1.28	0	0	16.01	11.65
2	5.03	5.36	8.35	6.49	0.22	1.29	0	0.05	0	0	13.60	13.19
3	3.58	3.80	12.70	12.08	0	0	0	0	0	0	16.28	15.38
4	3.26	6.69	13.46	3.77	0.22	0	0	0	0	0	16.94	10.46
5	4.63	4.86	8.40	7.96	1.60	0	0	1.18	0	0	14.63	14.00
6	3.22	3.96	13.04	11.62	0.87	0	0	0	0	0	17.13	15.58
7	2.06	6.58	17.09	3.93	0	0	0	0.15	0	0	19.15	10.66
8	4.34	4.66	10.53	9.61	0	0	0	0	0	0	14.87	14.27
9	1.97	6.35	17.16	4.71	0.11	0	0.10	0	0	0	19.34	11.09
10	4.30	2.17	10.63	16.77	0	0	0	0	0	0	14.93	18.94
11	2.07	5.97	17.04	5.84	0	0	0	0	0	0	19.11	11.81
12	1.10	6.54	19.85	3.34	0	0	0	0.95	0	0	20.95	10.83
13	5.41	2.77	7.45	14.72	0	0.39	0	0	0	0	12.86	17.38
14	4.54	3.63	9.96	11.56	0	0	0	0	0	0	14.50	16.19
15	2.62	4.52	15.48	10.01	0	0	0	0	0	0	18.10	14.53
16	0.68	6.06	21.05	5.57	0	0	0	0	0	0	21.73	11.63
17	6.81	3.85	3.43	11.68	0	0.31	0	0	0	0	10.24	15.84
18	0.96	6.29	20.24	4.92	0	0	0	0	0	0	21.20	11.21
19	3.13	3.73	14.01	12.28	0	0	0	0	0	0	17.14	16.01
20	4.44	5.75	10.24	6.46	0	0	0	0	0	0	14.68	12.21
21	5.78	3.32	6.39	13.46	0	0	0	0	0	0	12.17	16.78
22	3.06	0.68	14.19	21.05	0	0	0	0	0	0	17.25	21.73
23	2.26	2.80	16.49	14.95	0	0	0	0	0	0	18.75	17.75
24	0.61	3.29	21.25	13.55	0	0	0	0	0	0	21.86	16.84
25	0.58	1.98	21.32	17.32	0	0	0	0	0	0	21.90	19.30
26	1.52	0.22	13.85	15.76	0.08	0	0	0	5.13	7.18	20.58	23.16
27	0.06	2.34	22.84	16.28	0	0	0	0	0	0	22.90	18.62
28	6.96	3.48	2.99	10.81	0	2.66	0	0	0	0	9.95	16.95
29	5.85	2.18	5.96	12.93	0	1.32	0.25	2.95	0	0	12.06	19.38
30	6.82	2.08	1.86	14.44	1.38	3.44	0	0	0	0	10.56	19.66
31	7.19	4.26	2.00	4.00	0	8.18	0.35	0	0	0	9.54	16.44
32	4.77	3.32	7.20	6.07	0	0	0	0	2.28	8.03	14.25	17.42
33	7.92	4.35	0.23	9.41	0	0.25	0	0	0	0.95	8.15	14.96
34	7.64	3.50	1.04	7.57	0	6.52	0	0	0	0	8.68	17.59
35	4.69	3.15	9.79	7.66	0	6.94	0	0	0	0	14.38	17.95
36 Chain of Rocks*	8.00		0		0		0		0		8.00	
SUBPARAMETER WEIGHTS	0.15		0.23		0.28		0.25		0.16			

Table 8. SHORELINE TERRESTRIAL HABITAT SUBPARAMETER WEIGHTED RATINGS

	Forested Land		Open Land		Developed Land		Wetland		Shoreline Terrestrial Habitat Parameter Value (Sum)	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	23.23	9.54	5.60	7.5	0	2.33	0	5.22	28.88	24.59
2	23.88	27.51	3.48	2.07	0.65	0	0	0	28.01	29.58
3	24.12	19.11	2.55	9.08	0.94	0	0	0	27.61	28.19
4	26.94	24.99	1.45	1.18	0.45	1.20	0	0	28.84	27.37
5	20.01	26.76	8.33	2.25	0	0	0	0.63	28.34	29.64
6	22.50	26.79	6.10	0	0	0.75	0.21	1.12	28.81	28.66
7	27.78	18.42	0.35	2.06	0	3.03	1.40	0	30.03	23.51
8	14.13	27.24	13.23	1.22	0	0.43	0	0	27.36	28.89
9	27.39	27.90	1.93	0	0	0.70	0.35	0	29.67	28.60
10	17.28	20.94	10.08	4.46	0	1.23	0.74	0	28.10	26.63
11	27.24	19.65	2.30	7.75	0	0.35	0	0	29.54	27.75
12	20.43	21.27	7.98	2.00	0	2.11	0	0	28.41	25.38
13	12.18	26.49	14.35	0.20	0	1.05	0	0.14	27.03	27.38
14	9.57	17.97	15.58	10.03	0.58	0	0	0	25.73	28.00
15	21.63	8.94	6.18	2.15	0.32	6.16	0	0	28.13	17.25
16	12.39	13.80	14.40	4.83	0.11	3.47	0	0	26.90	22.10
17	6.48	3.39	19.60	0.33	0	8.74	0	0	26.08	12.46
18	7.80	0	18.50	0	0	10.00	0	0	26.30	10.00
19	12.33	0	8.75	0	2.39	10.00	0	0	23.47	10.00
20	3.39	0	0	0	8.85	10.00	0.07	0	12.31	10.00
21	0.84	0	1.70	0	9.04	10.00	0	0	11.58	10.00
22	1.41	0	3.34	0	8.18	10.00	0	0	12.93	10.00
23	16.02	2.82	7.25	0	1.76	9.06	0	0	25.03	11.88
24	24.18	5.04	3.20	2.95	0	7.14	2.31	0	29.69	15.13
25	23.49	6.81	4.58	13.40	0	2.37	1.19	0	29.26	22.58
26	10.39	6.27	15.80	6.65	0	4.68	0.18	2.00	26.37	19.60
27	9.99	7.38	16.53	17.28	0.08	0.63	0	0	26.60	25.29
28	23.28	13.38	3.95	9.43	0.33	0	1.16	6.20	28.72	29.01
29	10.41	9.48	11.50	11.45	1.25	0.18	2.38	7.28	25.54	28.39
30	7.50	12.48	3.60	14.60	5.91	0	0.53	0	17.54	27.08
31	9.03	13.44	2.15	6.93	6.13	0	0	2.63	17.31	23.00
32	7.53	15.21	0.15	6.23	7.43	1.16	0	4.48	15.11	27.08
33	10.17	7.23	0	4.75	6.61	1.19	0	15.75	16.78	28.92
34	24.66	14.07	3.25	4.95	0.43	0.69	0.18	9.24	28.52	28.95
35	18.21	20.79	1.85	1.73	1.47	0	6.02	8.33	27.55	30.85
36 Chain of Rocks	2.46		7.95		5.94		0.21		16.56	
SUBPARAMETER WEIGHTS	0.30		0.25		0.10		0.35			

4.2.3 Unweighted and Weighted Ratings for Avian Population Subparameters

The unweighted waterfowl ratings and eagle ratings used were derived from a graph of bird counts per mile versus river miles. These graphs and the supporting raw data are given in Appendix G, and were supplied by the Corps. The data for the graphs are from the Illinois Natural History Survey's Waterfowl Census (1973-1979).

No heron colony locations have been reported since the 1973-1977 Illinois Natural History Survey Census. The census itself did identify active colonies within the harbor at Crane ("Fults" or "Beagles") Island. This area is adjacent to the left bank subsegment between River Miles 138.8 and 140.8 which has been assigned a scale value of "10" (See Table 9).

Scaled values were then multiplied by the respective subparameter weights. The sum of the weighted subparameter values for each subsegment is the avian population value for that subsegment. Table 9 shows the weighted avian subparameter values and their sums.

4.2.4 Dredged Material Discharge, Dredging Frequency, Barge Activity, and Water Quality Values

The values for the dredged material discharge, dredging frequency, barge activity, and water quality parameters are presented in Appendix H. As these are simple parameters (i.e., not composed of subparameters), no subparameters or subparameter weights were needed to calculate these values.

4.2.5 Biological Analysis Parameter Ratings

In order to complete the final bioloigcal sensitivity analysis, the values for all of the parameters (taken from Tables 7 through 9 and Appendix H) were converted to 1-10 scales. The scaling used for each parameter is shown in Appendix I, and the scaled parameter values for each subsegment are presented in Table 10. These scaled values (unweighted parameter ratings) were multiplied by the appropriate parameter weights (from Table 4) to obtain the weighted parameter ratings shown in Table 11. The biological sensitivity rating for each subsegment was obtained by summing the weighted parameters, and is shown in Table 12.

Finally, the biological ratings were converted to a 1-10 scale to enable easy comparison between the subsegments. A high biological rating corresponds to a high scaled value. The scaling is shown in Appendix I and the scaled biological sensitivity values are presented in Table 12.

Table 9. AVIAN SUBPARAMETER SCALED RATINGS, AVIAN SUBPARAMETER WEIGHTED RATINGS, AND AVIAN POPULATION VALUE

	Scaled Avian Subparameter Ratings				Weighted Avian Subparameter Ratings				Avian Population Value	
	Waterfowl	Eagles	Herons		Waterfowl	Eagles	Herons			
Segment Number	Both Banks	Both Banks	Left Bank	Right Bank	Both Banks	Both Banks	Left Bank	Right Bank	Left Bank	Right Bank
1	6	5	10	1	1.98	1.80	3.00	0.30	6.78	4.08
2	6	5	1	1	1.98	1.80	0.30	0.30	4.08	4.08
3	6	6	1	1	1.98	2.22	0.30	0.30	4.50	4.50
4	6	6	1	1	1.98	2.22	0.30	0.30	4.50	4.50
5	6	6	1	1	1.98	2.22	0.30	0.30	4.50	4.50
6	6	6	1	1	1.98	2.22	0.30	0.30	4.50	4.50
7	6	6	1	1	1.98	2.22	0.30	0.30	4.50	4.50
8	5	6	1	1	1.65	2.22	0.30	0.30	4.18	4.18
9	5	6	1	1	1.65	2.22	0.30	0.30	4.18	4.18
10	5	5	1	1	1.65	1.80	0.30	0.30	3.75	3.75
11	4	4	1	1	1.32	1.48	0.30	0.30	3.10	3.10
12	4	4	1	1	1.32	1.48	0.30	0.30	3.10	3.10
13	4	3	1	1	1.32	1.11	0.30	0.30	2.43	2.43
14	3	2	1	1	0.99	0.74	0.30	0.30	2.03	2.03
15	3	2	1	1	0.99	0.74	0.30	0.30	2.03	2.03
16	3	2	1	1	0.99	0.74	0.30	0.30	2.03	2.03
17	2	1	1	1	0.66	0.37	0.30	0.30	1.33	1.33
18	2	1	1	1	0.66	0.37	0.30	0.30	1.33	1.33
19	2	1	1	1	0.66	0.37	0.30	0.30	1.33	1.33
20	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
21	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
22	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
23	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
24	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
25	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
26	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
27	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
28	1	1	1	1	0.33	0.37	0.30	0.30	1.00	1.00
29	1	2	1	1	0.33	0.74	0.30	0.30	1.37	1.37
30	2	2	1	1	0.66	0.74	0.30	0.30	1.70	1.70
31	3	3	1	1	0.99	1.11	0.30	0.30	2.40	2.40
32	-	-	1	1	1.32	1.48	0.30	0.30	3.10	3.10
33	5	6	1	1	1.65	2.22	0.30	0.30	4.15	4.15
34	7	8	1	1	2.31	2.96	0.30	0.30	5.57	5.57
35	10	10	1	1	3.30	3.70	0.30	0.30	7.30	7.30
36 (Chain of Rocks)	1*	1*	1*	1*	0.33	0.37	0.30	0.30	1.00	1.00
SUBPARAMETER WEIGHTS	0.33	0.37	0.30							

*No data available. A value of "1" is assigned due to the poor habitat potential of the canal for the three subparameters.

Table 10. BIOLOGICAL ANALYSIS PARAMETER SCALED RATINGS

	Aquatic Habitat		Shoreline Terrestrial Habitat		Dredged Material Discharge		Dredging Frequency		Barge Activity		Water Quality		Avian Population	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	6	3	10	7	6	10	7	10	10	7	10	8	10	5
2	4	4	9	10	10	10	10	10	9	10	10	10	5	5
3	6	6	9	9	10	10	10	10	10	10	10	10	6	6
4	6	2	10	9	9	10	8	10	10	9	10	8	6	6
5	5	4	9	10	10	10	10	10	10	10	10	8	6	6
6	7	6	9	9	10	10	10	10	10	9	10	3	6	6
7	5	2	10	7	10	10	10	10	10	10	10	3	6	6
8	5	5	9	10	10	10	10	10	9	10	10	10	6	6
9	8	3	10	9	7	10	5	10	10	10	10	8	6	6
10	5	5	9	8	8	10	8	10	10	9	10	10	5	5
11	8	3	10	9	5	10	4	10	10	5	10	8	4	4
12	9	2	9	8	7	9	7	7	10	9	10	10	4	4
13	4	7	9	9	10	10	10	10	8	10	10	10	3	3
14	5	6	8	9	1	10	1	4	8	8	8	10	2	2
15	7	5	9	4	1	10	1	10	9	1	10	7	2	2
16	10	3	9	6	7	10	7	10	9	9	10	8	2	2
17	2	6	8	2	1	10	1	6	2	7	10	1	1	1
18	9	3	3	1	9	8	9	7	9	8	9	6*	1	1
19	7	6	7	1	2	10	8	10	5	3	10	3*	1	1
20	5	3	2	1	3	10	5	10	3	1	5*	0*	1	1
21	3	6	1	1	7	7	5	7	6	6	5*	0*	1	1
22	7	10	2	1	10	1	10	1	8	9	1	6	1	1
23	3	7	8	1	4	1	3	1	9	8	9	10	1	1
24	10	6	10	3	8	10	8	10	10	9	10	10	1	1
25	10	8	10	7	10	10	10	10	10	10	10	4	1	1
26	9	10	9	5	10	10	10	10	10	9	10	9	1	1
27	10	8	8	8	9	10	7	10	10	10	8	9	1	1
28	2	6	9	10	10	9	10	8	10	10	10	10	1	1
29	3	8	8	9	6	10	5	10	6	7	2*	10	1	1
30	2	8	4	9	10	10	10	10	2	7	-1*	10	2	2
31	2	6	4	10	10	10	10	10	6	6	2	10	3	3
32	5	7	3	9	6	4	6	1	6	8	6	9	4	[illegible]
33	1	5	4	10	10	10	10	10	6	10	3	10	6	6
34	1	7	9	10	10	10	10	10	3	9	10	10	8	8
35	3	7	6	10	10	10	10	10	8	10	9	10	10	10
36 Chain of Rocks	1		4		10		10		10		10		1	
PARAMETER WEIGHTS	0.11		0.19		0.15		0.07		0.10		0.16		0.17	

*10 percent of 135 harbor spills reported by the U.S. Coast Guard in 1980 originated in these river subsegments. The scale value for these subsegments has been adjusted downward by two scale units.

Table 11. BIOLOGICAL ANALYSIS PARAMETER WEIGHTED VALUES

	Aquatic Habitat		Shoreline Terrestrial Habitat		Dredged Material Discharge		Dredging Frequency		Barge Activity		Water Quality		Avian Population	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	1.26	0.63	1.90	1.33	0.48	0.80	0.49	0.70	1.00	0.70	1.80	1.44	1.70	0.85
2	0.84	0.84	1.71	1.90	0.80	0.80	0.70	0.70	0.90	1.00	1.80	1.80	0.85	0.85
3	1.26	1.26	1.71	1.71	0.80	0.80	0.70	0.70	1.00	1.00	1.80	1.80	1.02	1.02
4	1.26	0.42	1.90	1.71	0.72	0.80	0.56	0.70	1.00	0.90	1.80	1.44	1.02	1.02
5	1.05	0.84	1.71	1.90	0.80	0.80	0.70	0.70	1.00	1.00	1.80	1.44	1.02	1.02
6	1.47	1.26	1.71	1.71	0.80	0.80	0.70	0.70	1.00	0.90	1.80	0.54	1.02	1.02
7	1.68	0.42	1.90	1.33	0.80	0.80	0.70	0.70	1.00	1.00	1.80	0.54	1.02	1.02
8	1.05	1.05	1.71	1.90	0.80	0.80	0.70	0.70	0.90	1.00	1.80	1.80	1.02	1.02
9	1.68	0.63	1.90	1.71	0.56	0.80	0.35	0.70	1.00	1.00	1.80	1.44	1.02	1.02
10	1.05	1.68	1.71	1.52	0.64	0.80	0.56	0.70	1.00	0.90	1.80	1.80	0.85	0.85
11	1.68	0.63	1.90	1.71	0.40	0.80	0.28	0.70	1.00	0.50	1.80	1.44	0.68	0.68
12	1.89	0.42	1.71	1.52	0.56	0.72	0.49	0.49	1.00	0.90	1.80	1.80	0.68	0.68
13	0.84	1.47	1.71	1.71	0.80	0.80	0.70	0.70	0.80	1.00	1.80	1.80	0.51	0.51
14	1.05	1.26	1.52	1.71	0.08	0.80	0.07	0.32	0.80	0.80	1.44	1.80	0.34	0.34
15	1.47	1.05	1.71	0.76	0.08	0.80	0.07	0.70	0.90	0.10	1.80	1.26	0.34	0.34
16	2.10	0.63	1.71	1.14	0.56	0.80	0.49	0.70	0.90	0.90	1.80	1.44	0.34	0.34
17	0.42	1.26	1.52	0.38	0.08	0.80	0.07	0.42	0.20	0.70	1.80	0.18	0.17	0.17
18	1.89	0.63	1.52	0.19	0.72	0.64	0.63	0.49	0.90	0.80	1.62	1.08	0.17	0.17
19	1.47	1.26	1.33	0.19	0.16	0.80	0.56	0.70	0.50	0.30	1.80	0.54	0.17	0.17
20	1.05	0.63	0.38	0.19	0.24	0.80	0.35	0.70	0.30	0.10	0.80	0.00	0.17	0.17
21	0.63	1.26	0.19	0.19	0.56	0.56	0.35	0.49	0.60	0.60	0.80	0.00	0.17	0.17
22	1.47	2.10	0.38	0.19	0.80	0.08	0.70	0.07	0.80	0.90	0.18	1.08	0.17	0.17
23	1.68	1.47	1.52	0.19	0.32	0.08	0.21	0.07	0.90	0.80	1.62	1.80	0.17	0.17
24	2.10	1.26	1.90	0.57	0.64	0.80	0.56	0.70	1.00	0.90	1.80	1.80	0.17	0.17
25	2.10	1.68	1.90	1.33	0.80	0.80	0.70	0.70	1.00	1.00	1.80	0.72	0.17	0.17
26	1.89	2.10	1.71	0.95	0.80	0.80	0.70	0.70	1.00	0.90	1.80	1.62	0.17	0.17
27	2.10	1.68	1.52	1.52	0.72	0.80	0.49	0.70	1.00	1.00	1.44	1.62	0.17	0.17
28	0.42	1.26	1.71	1.90	0.80	0.72	0.70	0.56	1.00	1.00	1.80	1.80	0.17	0.17
29	0.63	1.68	1.52	1.71	0.48	0.80	0.35	0.70	0.60	0.70	0.36	1.80	0.17	0.17
30	0.42	1.68	0.76	1.71	0.80	0.80	0.70	0.70	0.20	0.70	-0.18	1.80	0.34	0.34
31	0.42	1.26	0.76	1.90	0.80	0.80	0.70	0.70	0.60	0.60	0.36	1.80	0.51	0.51
32	1.05	1.47	0.57	1.71	0.48	0.32	0.42	0.07	0.60	0.80	1.08	1.62	[illegible]	0.68
33	1.21	1.05	0.76	1.90	0.80	0.80	0.70	0.70	0.60	1.00	0.54	1.80	1.02	1.02
34	1.21	1.47	1.71	1.90	0.80	0.80	0.70	0.70	0.30	0.90	1.80	1.80	1.36	1.36
35	1.05	1.47	1.71	1.90	0.80	0.80	0.70	0.70	0.80	1.00	1.62	1.8[illegible]	1.70	1.70
36	1.21		0.76		0.80		0.7[illegible]		1.00		1.80		[illegible]	
[illegible]														
PARAMETER WEIGHTS	0.21		0.19		0.08		0.07		0.11		0.18		0.27	

Table 12. BIOLOGICAL SENSITIVITY VALUES AND RANKINGS

Segment Number	River Miles	Biological Sensitivity Value		Ranking (1-10 Scale)	
		Left Bank	Right Bank	Left Bank	Right Bank
1	138.8-140.8	8.63	6.45	9	6
2	140.8-142.8	7.60	7.89	8	8
3	142.8-144.8	8.29	8.29	9	9
4	144.8-146.8	8.26	6.99	9	7
5	146.8-148.8	8.08	7.70	9	8
6	148.8-150.8	8.50	6.93	9	7
7	150.8-152.8	8.90	5.81	10	5
8	152.8-154.8	7.98	8.27	8	9
9	154.8-156.8	8.31	7.30	9	7
10	156.8-158.8	7.61	8.25	8	9
11	158.8-160.8	6.75	6.46	7	6
12	160.8-162.8	8.13	6.53	9	6
13	162.8-164.8	7.16	7.99	7	8
14	164.8-166.8	5.30	7.03	4	7
15	166.8-168.8	6.37	5.31	6	4
16	168.8-170.8	7.90	5.95	8	5
17	170.8-172.8	4.26	3.91	3	2
18	172.8-174.8	7.45	4.00	8	3
19	174.8-176.8	5.99	3.96	5	3
20	176.8-178.8	3.29	2.59	2	1
21	178.8-180.8	3.30	3.27	2	1
22	180.8-182.8	4.50	4.59	3	3
23	182.8-184.8	6.42	4.58	6	3
24	184.8-186.8	8.17	6.20	9	6
25	186.8-188.8	8.47	6.40	9	6
26	188.8-190.8	8.07	7.24	9	7
27	190.8-192.8	7.44	7.49	8	8
28	192.8-194.8	6.60	7.41	6	8
29	194.8-196.8	4.11	7.56	3	8
30	196.8-198.9	3.04	7.73	1	8
31	198.8-200.8	4.15	7.57	3	8
32	200.8-202.8	4.88	6.67	4	6
33	202.8-204.8	4.63	8.27	3	9
34	204.8-206.8	7.88	8.93	8	10
35	206.8-208.8	8.38	9.37	9	10
36	Chain of Rocks	5.44		5	

4.3 SUBSEGMENT EVALUATION

The final biological sensitivity value was determined by seven parameters, with considerable variability. Both within and among parameters, no single parameter dominates. A description and analysis of each subsegment is presented below. General conclusions are discussed in Section 5.

Subsegment 1L (River Miles 138.8 to 140.8)

This subsegment is dominated by forested lands with occasional grassy open areas. One section of this 219-hectare area has been cleared for agriculture. The aquatic habitat has value due to the predominance of main channel border and backwater. The subsegment has experienced little barge activity, dredging activity, or point source discharges. The avian population ranking is extremely high. The subsegment has a final ranking of 9, indicating an area relatively rich in biological resources and sensitive to the impacts of barge fleeting.

Subsegment 1R (River Miles 138.8 to 140.8)

This subsegment has a total area of 192 hectares; 84.1 hectares are aquatic and 108 hectares are terrestrial. The most distinctive feature is the power plant which accounts for the developed area. Two tributaries are contained in this subsegment: the Isle du Bois Creek at the lower end of the site and a smaller tributary at the upper end. The main channel dominates the aquatic habitat, making the habitat value relatively low. The subsegment has experienced little disturbance from barge fleeting or dredging, and has a high value for water quality. Avian population value is moderate. The relatively high final ranking (6) can be attributed primarily to the terrestrial habitat and the lack of aquatic disturbances.

Subsegment 2L (River Miles 140.8 to 142.8)

The total area of this subsegment (aquatic and terrestrial) is 221 hectares, with the aquatic and terrestrial areas being equally represented. Most of the 110 hectares of terrestrial habitat is forested; the levee accounts for most of the developed area. The open area is agricultural. A slight majority of the aquatic habitat is main channel, though there is a substantial amount of main channel border habitat. There has been little aquatic disturbance, as reflected in high values for barge activity, both dredging categories, and water quality. Avian population value is moderate. The final ranking is 8; this high ranking can be attributed primarily to good terrestrial habitat and the lack of aquatic disturbances.

Subsegment 2R (River Miles 140.8 to 142.8)

This subsegment is located at Harlow Island and covers a total of 235 hectares. The terrestrial habitat is almost all forest with one small agricultural clearing. Main channel habitat dominates the aquatic area, although there is a relatively large amount of backwater habitat. Like its sister subsegment, this subsegment has a final ranking of 8.

Subsegment 3L (River Miles 142.8 to 144.8)

Located at the towns of Osborne and Lillys, Illinois, this subsegment comprises a total of 238 hectares. The aquatic and terrestrial habitats are fairly equal in area. Most of the terrestrial area is forested and is valuable as habitat. The developed area is the levee; the open area has been cleared for agriculture. The aquatic habitat is composed of almost equal portions of main channel and main channel border, which gives it a moderate habitat value. Relatively little dredging has been done at this site. Barge activity and point source discharges are also minimal. The subsegment has a final ranking of 9.

Subsegment 3R (River Miles 142.8 to 144.8)

The northern portion of Harlow Island is contained in this subsegment. The total area is 246 hectares; 98 hectares are terrestrial and 148 hectares are aquatic. The forested lands, which slightly dominate the terrestrial habitat, are bordered by large agricultural open lands. Main channel border habitats are represented in the aquatic habitat in almost equal portions, giving this area a fair habitat value. Relatively little dredging has taken place here. Other aquatic disturbances are minimal. The final ranking is 9.

Subsegment 4L (River Miles 144.8 to 146.8)

This subsegment is located at Forest Home, Illinois, and occupies a total of 329 hectares. The terrestrial habitat is 90 percent forested; a large portion of this forested land is on an island. The habitat value of the island is high. Most of the open land is agriculture and all of the developed land is occupied by the levee. Main channel border dominates the aquatic habitat, giving it a fairly good habitat value. Dredging has been relatively limited in this area. Barge activity and point source discharges are also limited. The avian population value is moderate. The subsegment has a final ranking of 9.

Subsegment 4R (River Miles 144.8 to 146.8)

Situated at Selma, Missouri, this subsegment comprises 204 hectares. Of this total, 116 hectares are terrestrial and 88 hectares are aquatic. Fairly good forested land dominates the terrestrial habitat. The developed area is a large industrial complex and the open area is the town of Selma. The aquatic habitat is of low value since it is dominated (84 percent) by main channel. Relatively little dredging has taken place here. Barge traffic and water quality each have high scaled values. The avian population value is moderate. The final ranking is 7; the relatively high value results from the good terrestrial habitat and the lack of aquatic disturbances.

Subsegment 5L (River Miles 146.8 to 148.8)

This subsegment encompasses a large portion of Calico Island and is near the town of Mitchie, Illinois. It comprises a total of 313 hectares, 130 hectares of which are terrestrial and 183 hectares of which are aquatic. The favorable terrestrial habitats give a high habitat value. Forested areas are dominant in the terrestrial habitat; also present are open areas that have been used for agriculture. The aquatic habitat is dominated by main channel, but the relatively high proportion of backwater and main channel border habitat give the aquatic area a moderate value. There have been few aquatic disturbances. The site has a moderate avian population value, and a final ranking of 9.

Subsegment 5R (River Miles 146.8 to 148.8)

Located just below Crystal City, Missouri, this 158-hectare subsegment comprises 96 hectares of terrestrial habitat and 62 hectares of aquatic habitat. A stand of forest dominates the terrestrial habitat. The forest is interspersed with several open grassy areas and one wetland. This combination of habitat types makes this terrestrial area very valuable. Main channel slightly dominates the aquatic habitat, but this is offset by higher-value tributary (Plantin Creek) and main channel border habitats. The final ranking is 8; the relatively high biological sensitivity is due to excellent terrestrial habitat, minimal aquatic disturbances, and a moderate avian population value.

Subsegment 6L (River Miles 148.8 to 150.8)

This 288-hectare subsegment encompasses the northern portion of Calico Island. The 105 hectares of terrestrial land is extremely productive due to the stand of bottomland forest interspersed with backwater, wetland, and open areas. Open areas are used for agriculture. The aquatic habitat is dominated by main channel border; this in addition to the presence of backwater habitat make this a fairly valuable aquatic area. With minimal aquatic disturbances and a moderate value for avian populations, the subsegment has a final ranking of 9.

Subsegment 6R (River Miles 148.8 to 150.8)

Located at Crystal City, Missouri, this 166-hectare subsegment is composed of 107 hectares of terrestrial and 59 hectares of aquatic habitat. Developed lands are part of Crystal City. The majority of the terrestrial habitat consists of forested lands, making this a productive habitat. Significant in this subsegment is the relatively large area of valuable wetland habitat. The aquatic habitat is of moderate value since it is equally divided between main channel and main channel border areas. Minimal aquatic disturbances and a moderate avian population value contribute to the high final ranking of this subsegment (7).

Subsegment 7L (River Miles 150.8 to 152.8)

This subsegment occupies a total of 231 hectares; 101 hectares are terrestrial and 130 hectares are aquatic. The high terrestrial habitat value is due to the dominance of bottomland forest and a relatively large amount of wetland habitat. The aquatic area is also fairly valuable because main channel border predominates (74 percent). Minimal aquatic disturbances and a moderate avian population value, coupled with the high aquatic and shoreline terrestrial habitat values, give the subsegment a high final ranking of 10.

Subsegment 7R (River Miles 150.8 to 152.8)

Located at the town of Herculaneum, Missouri, this subsegment comprises 101 hectares of terrestrial and 98 hectares of aquatic area. Developed areas are significant in the terrestrial habitat due to Herculaneum. Forested areas still predominate, however, and there is one grassy open area. Low value main channel habitat forms the majority of the aquatic area, although there is one tributary, Joachim Creek. In spite of the minor aquatic disturbance and the moderate avian population value, the low aquatic habitat value limits the subsegment to a final ranking of 5.

Subsegment 8L (River Miles 152.8 to 154.8)

Most of Foster Island is encompassed by this subsegment of 250 hectares. The area is equally divided between terrestrial and aquatic habitats. The terrestrial area has a high value as a habitat with equal portions of forested and open lands. One of the two open areas is presently used for agriculture while the other may have undergone agricultural activities in the past. Main channel habitat slightly dominates the aquatic area, making this area only moderately productive. Dredging activities, barge activity, and point source discharges (water quality) are all insignificant. Avian population value is minimal. The subsegment has a final ranking of 8.

Subsegment 8R (River Miles 152.8 to 154.8)

Situated at Bushburg, Missouri, this subsegment encompasses 100 hectares of terrestrial and 102 hectares of aquatic habitat, for a total area of 202 hectares. A stand of bottomland forest dominates the terrestrial area, making this area a valuable habitat. The small amounts of developed and open areas are due to the town of Bushburg. Because the main channel dominates the aquatic habitat, this area is relatively low in value. With terrestrial habitat, dredged material discharge, dredging frequency, barge activity, and water quality all having scaled values of 10, and an avian population having a scaled value of 6, the final ranking is 9.

Subsegment 9L (River Miles 154.8 to 156.8)

This subsegment contains 217 hectares of total area; 86 hectares are terrestrial and 131 hectares are aquatic. The terrestrial area is very valuable with a good stand of bottomland forest interspersed with a small wetland and some open areas. Main channel border forms the majority of the aquatic habitat and Fountain Creek enters the Mississippi River at this site, so this is a very productive aquatic area. The subsegment has a final ranking of 9, due to the high scaled values for aquatic habitat, shoreline terrestrial habitat, both dredging parameters, barge activity, and water quality. Avian population is moderate.

Subsegment 9R (River Miles 154.8 to 156.8)

Located at Glen Park and lower Sulphur Springs, Missouri, this 96-hectare subsegment contains 102 hectares of terrestrial and 94 hectares of aquatic area. Most of the terrestrial habitat is bottomland forest with only a small amount of developed land. The aquatic habitat is of minimal value because it is composed almost entirely (71 percent) of main channel. The subsegment has experienced minimal aquatic disturbance and has a moderate avian population value. The final ranking is 7.

Subsegment 10L (River Miles 156.8 to 158.8)

This subsegment encompasses a total of 236 hectares; 96 hectares of this area are terrestrial and 140 hectares are aquatic. The terrestrial area is almost evenly divided between forested and open areas. The open areas appear to have been used for agriculture. Because main channel dominates the aquatic habitat, this area is not very productive. There has been minimal aquatic disturbance. The final ranking is 8.

Subsegment 10R (River Miles 156.8 to 158.8)

Located at Sunnyside and Flemings, Missouri, this subsegment comprises 180 hectares. The 96 hectares of terrestrial area includes a slight majority of forested land and substantial amounts of open and developed areas. Open areas are generally grassy areas; developed areas are associated with the aforementioned towns. The aquatic habitat is fairly valuable since it is dominated by main channel border (73 percent). Relatively high values for terrestrial and aquatic habitats coupled with insignificant barge activity and dredging activity and good water quality (resulting in high values) contribute to the final ranking of 9. The avian population value is moderate.

Subsegment 11L (River Miles 158.8 to 160.8)

Located near the town of Merrimae, Illinois, this subsegment encompasses 218 hectares. The terrestrial area is 132 hectares and the aquatic area is 96 hectares. A relatively sparse bottomland forest dominates the terrestrial portion; there is one area of grassy open land. Main channel border forms the majority (74 percent) of the aquatic area. The subsegment has minimal aquatic disturbance and a moderately low avian population value. A high terrestrial habitat value and a relatively high aquatic habitat value account for the final ranking of 7.

Subsegment 11R (River Miles 158.8 to 160.8)

This subsegment contains southern portions of Chelsey Island and the towns of Montebello and Kimmswick, Missouri. Of the 186 hectares, 100 are terrestrial habitat dominated by bottomland forest. The open land is a sparsely vegetated mudflat and the developed area is associated with Kimmswick. A majority of the 86 hectares of aquatic habitat is main channel. The combination of factors yields a relatively low aquatic habitat value with a high terrestrial habitat value. The subsegment has a low amount of barge activity and insignificant dredging and discharge activities. The avian population value is somewhat low, yielding a final ranking of 6.

Subsegment 12L (River Miles 160.8 to 162.8)

Situated at Lower Beard Island, this 111-hectare subsegment contains 111 hectares of terrestrial and 166 hectares of aquatic habitat. The majority of the terrestrial area is occupied by a fairly dense stand of bottomland forest. Agricultural open areas are also an important portion of this area. Main channel border dominates the aquatic habitat. The subsegment has minimal aquatic disturbance, a moderately low avian population value, and a final ranking of 9.

Subsegment 12R (River Miles 160.8 to 162.8)

This subsegment is located at Hillcrest and Whitehouse, Missouri, and covers a total of 193 hectares. One good stand of forest is contained in this subsegment, but the other stand is fairly sparse. One of the two developed areas is occupied by an industrial complex near Hillcrest; the other is associated with the town of Whitehouse. The aquatic habitat is dominated by the unproductive main channel, though this is slightly offset by the presence of the Meramac River and its tributary habitat. Scaled values for terrestrial habitat, barge activity, both dredging activities, and water quality are high. Aquatic habitat has a low scaled value and avian population a moderately low scaled value. The final ranking is 6.

Subsegment 13L (River Miles 162.8 to 164.8)

This subsegment is located on Beard Island and is composed of a total of 225 hectares that are equally divided between terrestrial and aquatic habitats. Agricultural open lands dominate the terrestrial habitat. A dense stand of bottomland forest separates the open lands from the Mississippi River. A majority of main channel habitat prevents the aquatic portion from being highly productive. Relatively little dredging has been performed at this subsegment. Terrestrial habitat value is high, aquatic habitat value is low, avian population value is low, and the other parameters have high scaled values. The subsegment has a final ranking of 7.

Subsegment 13R (River Miles 162.8 to 164.8)

Located at Bluff Springs, Missouri, this subsegment contains 283 hectares slightly dominated in area by the aquatic habitat. The terrestrial habitat is very productive with a forested area and wetland. The development is residential. Main channel border dominates the aquatic habitat. With a minimal aquatic disturbance and a low avian population value, the subsegment has a final ranking of 8.

Subsegment 14L (River Miles 164.8 to 166.8)

Terrestrial and aquatic habitats are equally represented in the 229-hectare subsegment. Agricultural open lands make up 62 percent of the terrestrial area. A commercial barge dock occupies the developed area. The forested area forms a woody edge on the riverbank. This terrestrial area is only moderately valuable as a habitat. This is also the case for the aquatic habitat since it is dominated by the main channel. The final ranking is 4; the ranking is due to the relatively good terrestrial habitat value coupled with high aquatic disturbance. There are low scaled values for aquatic habitat and avian populations.

Subsegment 14R (River Miles 164.8 to 166.8)

This subsegment is situated at the town of Grimsby, Missouri, and encompasses a total of 216 hectares. A stand of bottomland forest occupies slightly more of the 99-hectare terrestrial habitat than do the agricultural open lands. This area has fairly high habitat value. Because the aquatic area is almost evenly split between main channel and main channel border, it is of moderate value. The avian population scaled value is low, while scaled values of the dredging activities, barge activities, and water pollution are high. The final ranking is 7.

Subsegment 15L (River Miles 166.8 to 168.8)

Located at Carroll Island, this subsegment encompasses 174 hectares of terrestrial and 150 hectares of aquatic habitat. Two islands are contained in this subsegment. A fairly dense bottomland forest covers both of these islands and part of the mainland. Open lands are used for agriculture and the developed land is occupied by the levee. A majority of the aquatic area is main channel border, giving aquatic habitat a moderately high value. Some dredging has taken place here, though not in significant amounts. Barge activity and point source discharges are minimal. The avian population value is low. The subsegment has a final ranking of 6.

Subsegment 15R (River Miles 166.8 to 168.8)

This site is situated near Oakville, Missouri, and comprises 195 hectares. The terrestrial portion (104 hectares) is dominated by a quarry operation and is therefore of moderately low value as a habitat. The aquatic habitat (91 hectares) is also of moderate value due to a predominance of the main channel. Dredging has taken place and barge activity is high. Water quality has a high value while avian population has a low scaled value. The subsegment has a final ranking of 4.

Subsegment 16L (River Miles 168.8 to 170.8)

This subsegment comprises a total of 288 hectares, of which 106 hectares are terrestrial and 182 hectares are aquatic. Agricultural open lands form the majority (58 percent) of the terrestrial habitat. An edge of dense bottomland forest borders the open area. Main channel border habitat substantially dominates the aquatic habitat giving it a high value. Aquatic disruption has been insignificant. Overall, this subsegment is fairly valuable, with a ranking of 8.

Subsegment 16R (River Miles 168.8 to 170.8)

Located at Jefferson Barracks, this subsegment contains 103 hectares of terrestrial land and 165 hectares of aquatic habitat. The terrestrial area is almost equally divided between forested and developed lands; however, forested areas predominate. Developed land is associated with Jefferson Barracks and appears to be primarily residential in nature. Because the aquatic area is dominated (76 percent) by the main channel, it is not very valuable as habitat. Overall this subsegment is only slightly productive, despite minimal aquatic disturbance. The avian population value is low. The final ranking is 5.

Subsegment 17L (River Miles 170.8 to 172.8)

Situated near Vulcan, Illinois, this subsegment comprises a total of 231 hectares of which the aquatic area occupies a slight majority. The terrestrial habitat is dominated by agricultural open lands (78 percent). There are a few stands of bottomland forest. The aquatic habitat is dominated by the unproductive main channel. Relatively small amounts of material have been dredged here. This subsegment displays moderate terrestrial habitat, poor aquatic habitat, moderate barge activity, and low avian population value, which contribute to the final ranking of 3.

Subsegment 17R (River Miles 170.8 to 172.8)

Located in southern St. Louis, Missouri, this subsegment contains 112 hectares of terrestrial area and 104 hectares of aquatic area. A majority of the terrestrial area is occupied by industrial and residential development. The aquatic habitat includes essentially equal portions of main channel and main channel border and is therefore only slightly productive. The River Des Peres Drainage Channel enters the Mississippi River at this subsegment. Barge activity has a moderately high scaled value; dredging has a high scaled value; water quality is very low; and the avian population value is very low. The subsegment is ranked at 2.

Subsegment 18L (River Miles 172.8 to 174.8)

This subsegment is located near East Carondelet, Illinois, and includes 399 hectares. The 106 hectares of terrestrial habitat is dominated by agricultural open lands (74 percent). Bottomland forest is scattered around these open lands. The predominance of main channel border suggests a productive aquatic habitat. The avian population value is extremely low, but the remaining parameters have high scaled values. The final ranking is 8.

Subsegment 18R (River Miles 172.8 to 174.8)

Situated in lower St. Louis, Missouri, this subsegment encompasses a total of 200 hectares, of which 111 hectares are terrestrial and 89 hectares are aquatic. Industrial and residential development occupies all of the terrestrial area, making this area unproductive habitat. The aquatic habitat is also relatively unproductive because it is dominated by the main channel. There are high to moderately high scaled values for dredging activity, barge activity, and water quality, but very low scaled values for terrestrial habitat, aquatic habitat, and avian population. The subsegment has experienced harbor spills in the past. The final ranking is 3.

Subsegment 19L (River Miles 174.8 to 176.8)

Located at Arsenal Island, this subsegment encompasses a total of 215 hectares which contain almost equal portions of terrestrial and aquatic areas. The terrestrial area consists of open lands. Developed areas are associated with commercial docks. In the aquatic portion, there is a slight majority of main channel border. Dredging activities are moderate as are point source discharges. There is some barge activity, although the scaled value is moderately high. Avian population has a very low value, contributing to the final ranking of 5.

Subsegment 19R (River Miles 174.8 to 176.8)

Situated in St. Louis, Missouri, this subsegment contains 115 hectares of terrestrial area and 106 hectares of aquatic area. All of the terrestrial area is industrially and residentially developed, and has a very low value. The main channel and main channel border are equally represented in the aquatic habitat. While dredging activities are insignificant, there is a moderate amount of barge activity and point source discharges. There have also been some harbor spills. The avian population value is very low. The final ranking is 3.

Subsegment 20L (River Miles 176.8 to 178.8)

This subsegment is in East St. Louis and occupies a total of 257 hectares which are equally divided between terrestrial and aquatic areas. Most of the terrestrial area is composed of industrial facilities and related areas and is therefore not valuable as a habitat. Although it does contain a significant amount of main channel border, the aquatic habitat is dominated by the main channel and has only moderate value. While little dredging activity has occurred, there are moderate amounts of barge activity and point source discharges, as well as harbor spills, and a very low value for avian populations. The final ranking is 2.

Subsegment 20R (River Miles 176.8 to 178.8)

Located in St. Louis, this subsegment contains 111 hectares of terrestrial habitat and 96 hectares of aquatic habitat. The entire terrestrial area has been developed by industry. A majority of the aquatic habitat is occupied by the main channel. While there has been little dredging (giving both dredging parameters high scaled values), all other parameters have very low scaled values. The water quality value was lowered by the past history of harbor spills to a scaled value of 0. The final ranking of the subsegment is 1.

Subsegment 21L (River Miles 178.8 to 180.8)

Encompassing part of East St. Louis, this subsegment covers a total of 194 hectares. The 102 hectares of terrestrial area is almost totally developed. This development plus the dominance of the main channel in the aquatic area prevent this subsegment from being valuable habitat. Dredging activities are minimal. Both barge activity and water quality have moderately high scaled values, although there have been some harbor spills. Avian population has a very low value. The final ranking is 2.

Subsegment 21R (River Miles 178.8 to 180.8)

This subsegment is in St. Louis and occupies a total of 165 hectares, of which 96 hectares are terrestrial and 69 hectares are aquatic. The entire terrestrial portion has been developed industrially. The aquatic habitat is equally divided between main channel and main channel border. Thus, this subsegment has minimal habitat value. The subsegment has moderate dredged material discharge and dredging frequency, moderate barge activity, and a relatively large number of point source discharges, as well as some past harbor spills (the water quality scaled value is 0). Avian population has a very low scaled value. The subsegment has a final ranking of 1.

Subsegment 22L (River Mikes 180.8 to 182.8)

Located just north of East St. Louis, this subsegment encompasses 111 hectares of terrestrial area and 138 hectares of aquatic area. Most of the terrestrial habitat is industrial. The main channel border occupies a slight majority of the aquatic portion, although there is a substantial amount of main channel habitat. Dredging activities have high scaled values, as does barge activity. Water quality is moderate and the avian population value is low. The final ranking is 3.

Subsegment 22R (River Miles 180.8 to 182.8)

Situated in upper St. Louis, this subsegment consists of a total of 176 hectares. The 101 hectares of terrestrial area are industrially developed and are of no value as wildlife habitat. Since almost all of the aquatic habitat is main channel border, this is a highly valued area. A large volume of dredged material has been discharged in the area at a relatively low frequency. Barge activity is minimal, water quality is moderately high in scaled value, and the avian population value is low in scaled value. The subsegment has a final ranking of 3.

Subsegment 23L (River Miles 182.8 to 184.8)

Located near Venice, Illinois, this subsegment comprises a total of 269 hectares. About half of the 85 hectares of terrestrial area is forested. The developed land is occupied by the levee; part of the open land is associated with commercial docking operations. Most of the 184 hectares of aquatic area is main channel border. Aquatic disturbance has been minimal. The avian population value has a very low scaled value. The subsegment has a final ranking of 6.

Subsegment 23R (River Miles 182.8 to 184.8)

This subsegment is in upper St. Louis and is composed of a total of 162 hectares. Essentially all of the terrestrial area (104 hectares) is industrially developed. The aquatic habitat (58 hectares) has a slight predominance of main channel border, the rest being main channel. Barge activity and water quality have very high scaled values, as does dredged material discharge. However, dredging frequency has a very low scaled value, indicating the subsegment has had small amounts of dredged material discharged frequently. The avian population value is very low. The subsegment has a moderately low ranking of 4.

Subsegment 24L (River Miles 184.8 to 186.8)

The lower part of Mosenthien Island and a part of Cabaret Island are contained in this 546-hectare subsegment. On Cabaret Island there are fairly equal portions of bottomland forest and relatively sparse open lands. Mosenthien Island contains a mixture of forest and numerous wetlands which make this area very valuable. Almost all of the 317 hectares of aquatic area are main channel border. Overall, this subsegment is an extremely productive habitat with high values for all parameters except avian population. The final ranking is 9.

Subsegment 24R (River Miles 184.8 to 186.8)

Situated below BelleFontaine Neighbors, this 191-hectare subsegment contains 117 hectares of terrestrial area and 74 hectares of aquatic area. The terrestrial area is mostly developed, because of the levee. There is a small woody edge of bottomland forest and one small grassy open area. The aquatic area has a slight majority of main channel border with the rest being the main channel. This subsegment is a mediocre habitat, with a final ranking of 6. The subsegment has a very low avian population scaled value, a low shoreline terrestrial habitat value, and a mediocre aquatic habitat value.

Subsegment 25L (River Miles 186.8 to 188.8)

The northern part of Mosenthien Island and portions of Cabaret Island are included in this 565-hectare subsegment. Some agricultural open land and a small edge of forest are located on Cabaret Island. The habitat of Mosenthien Island is a mixture of bottomland forest and scattered wetlands. Main channel border habitat predominates in the aquatic portion (310 hectares). This subsegment is an extremely valuable habitat with high scaled values for all parameters except avian population, which is very low. The subsegment has a final ranking of 9.

Subsegment 25R (River Miles 186.8 to 188.8)

This subsegment is at Riverview, Missouri, and comprises a total of 224 hectares. Half of the 119-hectare terrestrial area is grassy open area and a small amount is forested. Two portions of the developed area are open pits of undetermined nature; one appears to be a quarry. Another section of the developed area is residential. A majority of the 105-hectare aquatic habitat is main channel border. Water quality, shoreline terrestrial habitat, and aquatic habitat have moderate scaled values; avian population has a low value; and the other parameters are all scaled high. The final ranking is 6.

Subsegment 26L (River Miles 188.8 to 190.8)

Located on lower Chouteau Island, this subsegment contains a total of 357 hectares, of which 188 hectares are terrestrial and 239 hectares are aquatic. Most of the terrestrial area consists of agricultural open lands with some bottomland forest and one wetland. The aquatic area is mostly main channel border. There is also some tailwater downstream of Dam No. 27. This subsegment is a fairly valuable habitat with a final ranking of 9. Only a minimal amount of dredging has been done here. The avian population value is low and all other parameters have high scaled values.

Subsegment 26R (River Miles 188.8 to 190.8)

This subsegment is near Riverview, Missouri, and is a total of 214 hectares. About half of the 91 hectares of terrestrial area is developed and is occupied by a waterworks plant. A thin edge of bottomland forest and some grassy open areas occupy the remainder of the terrestrial area and provide a small amount of fairly good habitat. Main channel border dominates the aquatic area (123 hectares) and is accompanied by tailwater and a negligible amount of main channel habitat. All other parameters have very high scaled values except avian population, which is low. The subsegment has a final ranking of 7.

Subsegment 27L (River Miles 190.8 to 192.8)

Located on the upper part of Chouteau Island, this subsegment encompasses 111 hecatres of terrestrial habitat and 86 hectares of aquatic habitat. Agricultural open lands represent a majority of the terrestrial habitat. The area also contains a strip of bottomland forest. Almost all of the aquatic area is main channel border, providing a moderate aquatic habitat. Aquatic disturbance has been minimal, with some point source discharges. Avian population has a very low value. The subsegment has a final ranking of 8.

Subsegment 27R (River Miles 190.8 to 192.8)

Situated just above Riverview, Missouri, the subsegment covers a total of 432 hectares, the majority of which is aquatic (296 hectares). Most of the terrestrial area consists of lands that have been cleared for agriculture. The open land is interspersed with forest. A majority of the aquatic habitat is main channel border. This subsegment has moderately high values for shoreline terrestrial and aquatic habitats; very high scaled values for dredging activities, barge activity, and water quality; and an extremely low value for avian population. The final ranking is 8.

Subsegment 28L (River Miles 192.8 to 194.8)

This subsegment is located at upper Chouteau Island and has an area of 146 hectares. The terrestrial area (88 hectares) is dominated by a stand of bottomland forest which provides valuable habitat. Open lands are agricultural and the developed land is the levee. There are two small wetlands at this subsegment. Most of the aquatic habitat (58 hectares) is main channel, resulting in a low value for aquatic habitat. With the exception of avian population, which has a low scaled value, the remainder of the parameters have very high scaled values. The subsegment has a moderate ranking of 6.

Subsegment 28R (River Miles 192.8 to 194.8)

This subsegment encompasses a total of 285 hectares which are almost equally divided between aquatic and terrestrial areas. The terrestrial portion has a productive mixture of forest and wetland habitats. There are also some agricultural open lands. Main channel and main channel border habitats are equally represented in the aquatic area. The area has undergone minimal aquatic disturbance. The avian population value is very low. The final ranking is 8.

Subsegment 29L (River Miles 194.8 to 196.8)

Located near Hartford, Illinois, this subsegment contains 101 hectares of terrestrial and 86 hectares of aquatic area. A majority of the area is open and a significant portion of it is forested with some wetland area. The main channel dominates the aquatic habitat, although there is some tributary habitat. There is some barge activity, and the scaled value for water quality is moderately low. The avian population value is very low. The subsegment has also experienced harbor spills. Final ranking is 3.

Subsegment 29R (River Miles 194.8 to 196.8)

This subsegment contains part of upper Duck Island and part of Mobile Island. The total area of the site is 268 hectares, 97 hectares of which are terrestrial and 171 hectares are aquatic. Duck Island is a very valuable habitat with forested areas and interspersed wetlands. The land on Mobile Island is not as productive because it has been cleared for agriculture. The aquatic habitat is dominated by main channel border and contains significant amounts of backwater and tributary habitats. Aquatic disturbance has been minimal. The avian population value is low. The subsegment has a final ranking of 8.

Subsegment 30L (River Miles 196.8 ro 198.8)

This subsegment is near Wood River, Illinois, and encompasses 120 hectares of terrestrial area and 86 hectares of aquatic area. Over half of the terrestrial portion is developed by industry. All of the shoreline is developed and has numerous commercial docks. The main channel dominates the aquatic habitat, although there is some backwater and main channel border habitat. This area has not been dredged. Shoreline terrestrial and aquatic habitat have low values, barge activity is high, water quality is very low (due in part to harbor spills), with a scaled value of -1, and the avian population has a low scaled value. The subsegment has a ranking of 1.

Subsegment 30R (River Miles 196.8 to 198.8)

Situated on Mobile Island, this subsegment covers a total of 260 hectares. Most of the terrestrial area on Mobile Island is occupied by agricultural open lands bordered by an edge of forest. This subsegment also contains some small islands that are covered with bottomland forest and are surrounded by backwater and main channel border. This combination of habitats is very productive. Most of the aquatic area (160 hectares) is main channel border. This area has not been dredged. Actual barge activity is low, accounting for the high scaled value. Avian population has a low value. The subsegment has a final ranking of 8.

Subsegment 31L (River Miles 198.8 to 200.8)

Located near East Alton, Illinois, this subsegment contains a total of 193 hectares. Most of the 107 hectares of terrestrial habitat has been developed by a power plant and by the levee. Most of the shoreline is also developed. The subsegment does have a few stands of forest and some grassy area, but these are not significant enough to give this area value as a habitat. The main channel dominates the aquatic habitat (86 hectares). This area has not been dredged. Barge activity has a moderately high value, but water quality is moderate, and the avian population value is low. The subsegment has a low ranking of 3.

Subsegment 31R (River Miles 198.8 to 200.8)

This subsegment encompasses most of Maple Island and comprises 405 hectares. Most of the 293 hectares of terrestrial area is forested. A mixture of bottomland forest and wetlands are represented on Maple Island, making this area a very productive habitat. The island is surrounded by a large amount of backwater habitat. A substantial amount of agricultural open land occupies the mainland portion of this subsegment. Slightly over half of the aquatic habitat (112 hectares) is main channel. This area has not been dredged. The values for most of the parameters are high, except for a moderately low value for avian population. The subsegment has a ranking of 8.

Subsegment 32L (River Miles 200.8 to 202.8)

Located near Alton, Illinois, this subsegment contains a total of 192 hectares which is evenly divided between aquatic and terrestrial areas. The terrestrial portion is almost entirely developed with industry, industrial wastelands, and the levee. The levee is bordered by a thin wooded fringe. Most of the aquatic habitat is main channel. Overall this subsegment has little habitat value. Dredging activity has been minimal. Both barge activity and water quality are scaled moderately high, while the avian population value is moderately low. The final ranking is 4.

Subsegment 32R (River Miles 200.8 to 202.8)

Encompassing Ellis Island, this subsegment contains a total of 429 hectares, of which 307 hectares are terrestrial and 122 hectares are aquatic. A valuable combination of bottomland forest and wetlands is present at this area. The open lands have been cleared for agriculture. There is a small area of developed lands on Ellis Island. Main channel dominates the aquatic area followed by tailwater and then main channel border. This subsegment has a final ranking of 6. Aquatic disturbances have been minimal. The avian population value is moderate.

Subsegment 33L (River Miles 202.8 to 204.8)

This subsegment is in upper Alton, Illinois, and it covers a total of 168 hectares. Most of the 109 hectares of terrestrial area is developed although there is some scattered forest. The main channel occupies almost all of the aquatic portion (59 hectares). Aquatic habitat is thus extremely low, while terrestrial habitat is also rather low. Although minimal dredging activity has occurred, there is some barge activity, and there are some point source discharges. The avian population value is moderate. The final ranking is 3. It should be noted that construction, including land clearing, is ongoing for new Lock and Dam No. 26 at River Mile 202.9 and this will reduce terrestrial habitat value to an unknown degree.

Subsegment 33R (River Miles 202.8 to 204.8)

Located near West Alton, Missouri, this subsegment encompasses 282 hectares of terrestrial and 331 hectares of aquatic habitat. Wetlands represent almost half of the terrestrial area, making this an extremely valuable habitat. Bottomland forest, grassy and agricultural open areas, and residential and commercially developed areas are also represented. The wetland area and portions of the forest have been designated as a wildlife sanctuary. The aquatic area has a slight majority of main channel habitat, the rest being main channel border, backwater, and tailwaters. Except for moderate aquatic habitat and avian population values, all other parameters have high scaled values. The final ranking is 9. Here too, construction of Lock and Dam No. 26 (River Mile 202.9) will lower the habitat values for aquatic and terrestrial areas.

Subsegment 34L (River Miles 204.8 to 206.8)

Situated below Clifton Terrace, Illinois, this subsegment includes 248 hectares, of which 107 hectares are terrestrial and 141 hectares are aquatic. Bottomland forest covers most of the terrestrial area. There are small amounts of grassy open areas and some residential development. Almost all of the aquatic area is occupied by the main channel. Barge activity is moderate and the avian population value is moderately high (scaled value). The subsegment has insignificant dredging activity. The final ranking is 8.

Subsegment 34R (River Miles 204.8 to 206.8)

Encompassing lower Dresser Island, this subsegment consists of 225 hectares of terrestrial and 289 hectares of aquatic area. The terrestrial portion contains a very productive combination of forest, wetlands, and open areas. A large section of this area is designated as a wildlife sanctuary. There is a small amount of residential development in the area. The main channel occupies slightly less than half of the aquatic habitat, followed in size by the main channel border and then by backwater. Except for aquatic habitat and avian population, which have moderately high scaled values, all the parameters have very high values. The subsegment has a final ranking of 10.

Subsegment 35L (River Miles 206.8 to 208.8)

Located at Clifton Terrace, Illinois, this subsegment occupies a total of 332 hectares. The 116 hectares of terrestrial habitat is mostly forest with residential and open areas interspersed. The lower part of Plasa Island is contained in this subsegment and consists of bottomland forest and wetland. The main channel occupies slightly more of the aquatic area (216 hectares) than does the main channel border. The subsegment has high values for all parameters except aquatic habitat, which is moderate. The final ranking is 9.

Subsegment 35R (River Miles 206.8 to 208.8)

This subsegment contains the upper part of Dresser Island and occupies an area of 603 hectares. Most of the 266 hectares of terrestrial area are bottomland forest accompanied by a significant amount of wetland and a small area of agricultural open area. Most of this area has been designated as a wildlife sanctuary. The main channel slightly dominates the 337-hectare aquatic area, followed closely by main channel border and tailwater. There is a moderately high value for aquatic habitat, and extremely high values for all other parameters. The final ranking is 10.

Subsegment 36 (Chain of Rocks Canal)

This subsegment encompasses a total 1,069 hectares, 827 hectares of which are terrestrial and 242 hectares are aquatic. The size of the canal subsegment is larger than the other subsegments as it was not broken into two-mile segments of left and right bank subsegments. This was due to the area's uniformity and its low potential for barge fleeting. The problem is in the narrow width of the canal, which would be extremely restrictive in terms of a fleeting area. Most of the terrestrial area is developed in connection with the levee. The open areas are used primarily for agriculture. Because this is a canal, all of the aquatic portion is main channel. This subsegment has a final ranking of 5.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The final biological sensitivity values and ranking on a 1-10 scale for the subsegments are shown in Table 12. These values and their rankings are intended to provide an informational base relative to the biological value and sensitivity to perceived fleeting impacts for various subsegments identified within St. Louis Harbor.

The sections below present general conclusions on the seven biological parameters and on the final rankings of the subsegments.

5.1.1 Aquatic Habitat

The aquatic habitat parameter is dependent primarily on two of its five subparameters: main channel and main channel border. These two subparameters are the largest in area to a degree which overshadows most of the contributions made by the other subparameters. Unweighted ratings for the subparameters (Table 5) show no discernible patterns.

The final scaled ratings for the aquatic habitat parameter (Table 10) show no significant patterns, being highly variable from subsegment-to-subsegment. There is one section of the Mississippi River, however, which consistently shows high ratings for aquatic habitat. Subsegments 22 through 27 (River Miles 180.8 to 192.8) are all rated at 6 or above, with three subsegments on the left bank (Nos. 24, 25, and 27) having ratings of 10.

5.1.2 Shoreline Terrestrial Habitat

The shoreline terrestrial habitat parameter is composed of four subparameters, three of which (forested lands, open lands, and developed lands) contribute most of the value because of their areal prevalence. Forested lands and open lands have no significant patterns, although the lower portion of the study area has a heavier forest concentration. The area around St. Louis (River Miles 170.8 to 186.8) is predominantly developed land, often to the exclusion of other types of terrestrial habitat. The fourth subparameter, wetlands, does not have a significant input because of its scarcity. The excpetion to this occurs at Subsegments 32 through 35 (River Miles 200.8 to 208.8) on the right bank, where wetlands occupy from 13 to 45 percent of the subsegments' land area.

The final scaled ratings for shoreline terrestrial habitat (Table 10) reflect the attributes described above. The ratings are consistently high for Subsegments 1 through 4 (River Miles 138.8 to 168.8); generally lower for Subsegments 15 through 27 (River Miles 168.8 to 192.8), particularly for the right bank Subsegments 17 through 24 (River Miles 170.8 to 186.8); and generally higher again for Subsegments 28 through 35 (River Miles 192.8 to 120.8), with the right bank subsegments showing consistently high ratings.

5.1.3 Dredged Material Discharge

An analysis of the dredged material discharge data presented in Table H-1, Appendix H, shows that most of the dredging has occurred in the left bank Subsegments 9 through 12 and 14 through 12 (River Miles 154.8 to 162.8 and River Miles 164.8 to 180.8, respectively). Other left bank subsegments were also dredged. The right bank subsegments showed almost no dredging, except for Subsegments 21 through 23 (River Miles 178.8 to 184.8) which had extremely high values (particularly Subsegments 22 and 23).

5.1.4 Dredging Frequency

An analysis of the dredging frequency data contained in Table H-2, Appendix H, shows that, while dredging frequency is relevant only to those subsegments also addressed by dredged material discharge, there is no significant correlation between the number of times a subsegment has been dredged and the volume of dredged material discharged. The dredging frequency is highly variable from subsegment to subsegment. The right bank subsegment of Segment 23 (River Miles 182.8 to 184.8) has a very high frequency of dredging relative to the other subsegments (more than double the frequency).

5.1.5 Barge Activity

Analysis of the barge activity data in Table H-2, Appendix H, shows no distinct river areas wherein most of the barge activity occurs. Segments 13 to 23 (River Miles 162.8 to 184.8) and Segments 29 to 35 (River Miles 194.8 to 208.8) contain virtually all of the barge activity recorded. Within these two river sections, barge activity is highly variable without any discernible patterns between subsegments, with the exception of relatively high concentrations of barges at Segments 19, 20, and 21 (River Miles 174.8 to 180.8) and the left bank Subsegments 29 to 35 (River Miles 194.8 to 208.8).

5.1.6 Water Quality

Data for the water quality parameter consists of the ratio of the number of point source discharges to aquatic area (hectares) for each subsegment. Analysis of the data shown in Table H-4, Appendix H, reveals that most of the point source discharges occur in the St. Louis area in Segments 15 to 22 (River Miles 168.8 to 182.8) and along the left bank Subsegments 29 to 33 (River Miles 194.8 to 204.8). In addition, there are a few point source discharges in the right bank Subsegments 4 through 7 (River Miles 144.8 to 152.8).

Subsegments which accounted for 80 percent of harbor spills reported by the U.S. Coast Guard in 1980 were dropped two scale units from their original placement on the 1-10 scale. These are right bank Subsegment 18, right bank Subsegment 19, left and right bank Subsegments 20, left and right bank Subsegments 21, left bank Subsegment 29, and right bank Subsegment 30. Of interest are the final scaled values of left bank Subsegment 30, which has a value of -1 after being dropped two scale units, and right bank Subsegments 20 and 21, which have values of 0 after dropping two scale units.

5.1.7 Avian Population

An analysis of the avian population parameter data expressed in Table 9 shows a very distinct pattern for the study area. The avian population value is inversely proportional to developed land area, having relatively high values at the two ends of the study area dropping gradually but consistently toward a section of river slightly off-center at Segments 20 through 27 (River Miles 176.8 to 192.8) with low values. Of the three subparameters on which the avian population parameter is based, eagles and waterfowl basically follow the pattern described above. Herons, due to the method used in determining the original values for herons per subsegment, have a consistently low value throughout the study area except for left bank Subsegment 1 (River Miles 138.8 to 140.8) which has a high value.

5.1.8 Final Biological Sensitivity Values and Ranking

Analysis of the final 1-10 scaled ranking of the biological sensitivity values of the subsegments shows a pattern similar in nature to those of the individual biological parameters. Sections of the Mississippi River with generally low scaled values are found in the St. Louis area and on the left bank near the upper reaches of the study area. High scaled values are found at both ends of the study area, extending toward the center from downriver and along the right bank upriver. It should be noted that a tremendous variability exists between the subsegments and their respective parameter values. An example is the obvious concentration of developed land (a shoreline terrestrial subparameter)

in the metropolitan St. Louis area. In those subsegments with a high percentage of developed land, final scaled values ranged from 1 to 5. Thus, individual biological characteristics of a subsegment can not be judged solely on the basis of its final scaled value.

An additional limitation inherent within the study is the arbitrary breakdown of the Mississippi River into two-mile segments. While many of the biological parameters form a loose continuum along the river, changing the subsegment boundaries will still obviously alter the final values. Therefore, this study provides biological sensitivity data which is applicable only on a broad scale within the designated subsegments. While useful as one part of a planning or decision-making informational base, this study was not intended to provide analyses as to the biological sensitivity of a specific site to fleeting.

The results shown in Table 12 are best used as a screening tool to identify those subsegments with a relatively high biological value and sensitivity. Subsegments identified as being relatively high in biological value and sensitivity should not have fleeting prohibited merely on that basis. Rather, planners, regulatory agencies, and commercial interests should be aware that subsegments with relatively high final rankings are more sensitive to the potential impacts of fleeting and thus may require more careful consideration or review. Obviously, fleeting decisions must be made in view of economic concerns, navigational concerns, and many other factors, including a more detailed biological analysis than provided in this report.

It should be noted that the above values are based on existing conditions only. The parameter values for aquatic habitat and shoreline terrestrial habitat in particular are subject to change over time. The construction of replacement Lock and Dam No. 26 at River Mile 202.9 is a good example. The construction and land clearing was begun after the 1979 aerial photography series was completed. Thus, it was not considered by the methodology in the determination of shoreline terrestrial habitat for Segment 33, both subsegments.

5.2 RECOMMENDATIONS

Several of the parameters suffered a loss of information during placement into their respective 1-10 scales during preparation of the draft report. This was due to the inadequacies of fitting a scale with equal intervals over data which are not evenly distributed over its range. Dredged material discharge, dredging frequency, and to a lesser extent, barge activity and water quality all had data with one or more values which were extremely large, resulting in a skewed 1-10 scale with a loss of resolution at the lower end of the data. This results in a

loss of differences between subsegments as the values become homogenized by the scale. Aquatic habitat, shoreline terrestrial habitat, and avian population values were all fairly evenly distributed over their respective ranges.

In order to alleviate this problem, the 1-10 scales for the four parameters were adjusted. Zero data points were set equal to a scaled value of 10 (all four parameters are negative measures of a subsegment's biological sensitivity). The remainder of the scaled values were distributed at equal intervals over the bulk of the data points, with the scaled value 1 being left open-ended to include those exceptionally large data points.

Future studies of a similar nature should consider this technique as well as using various statistical methods (e.g., percentiles, standard deviation units) to fit the 1-10 scales with unequal units which will allow a sharper differentiation between the parameter values for each subsegment. The applicability of these methods depends upon the parameter and the significance of the data in terms of its definition, distribution, and range.

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APPENDIX A

ST. LOUIS HARBOR STUDY BACKGROUND

Source: U.S. Army Corps of Engineers, St. Louis District, 1981.

1. **Name:** St. Louis Harbor, Missouri and Illinois, 58330

2. **Purpose / Problems.** There is a dual purpose to this study as a result of two separate and distinct Congressional Resolutions. The first, adopted in June 1964, authorized a study of the causes of sedimentation within the St. Louis Harbor and a determination of the most feasible means of reducing or eliminating this condition. The second, adopted in May 1971, authorized a study to determine the advisability of providing improved commercial harbor facilities at and in the vicinity of St. Louis, Missouri. The harbor limits at the time of the initial resolution were considered to be Mile 172 to Mile 191 above the mouth of the Ohio River. Subsequent to the second resolution, local interests petitioned the Corps to extend harbor limits to more closely define existing limits of port/harbor developments. The harbor limits were thus extended to include both banks of the river from Mile 138.8 to 208.8. The problem which is addressed by the 1964 resolution was that sediment was being deposited within the 19-mile reach of the river (outside of the navigation channel) in local areas, which prevented access to some docks during low flow. The problem addressed by the later resolution expressed the concern of local interests that while through tonnage was increasing year by year that tonnage on and off loaded within the 70-mile reach was not keeping pace.

3. **Funding:**

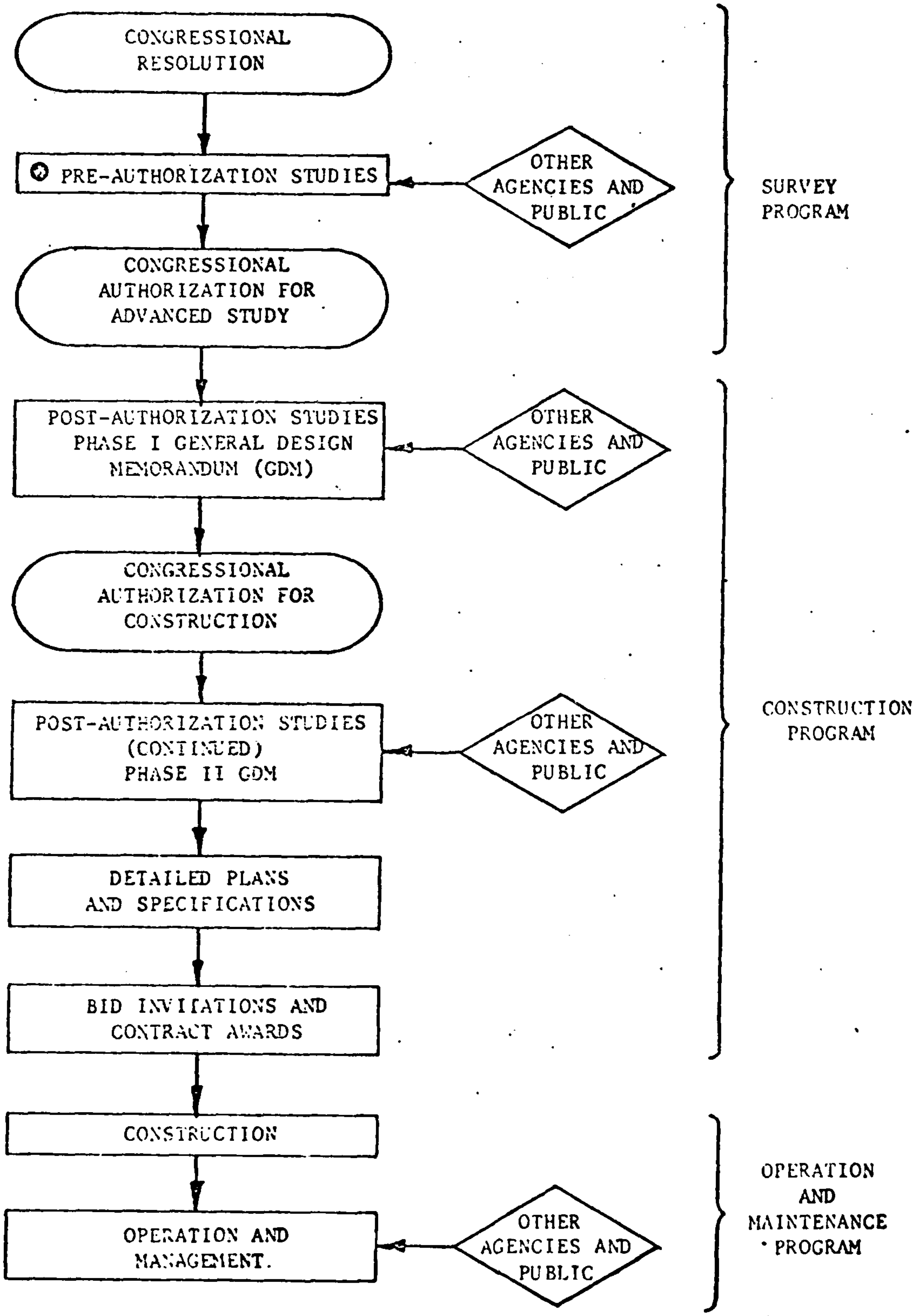
Total Study Cost	$2,200,000
Allocation thru FY 79	1,323,000
Budget Estimates, FY 80	317,000

4. **Study Schedule:**

Initiation	FY 66	
Stage I Completion	FY 73	Quarter 3d
Stage II Completion	FY 78	Quarter 3d
Submit Draft Report	FY 80	Quarter 4th
Submit Final Report	FY 81	Quarter 1st

5. **Major Work Items, FY 80:** Draft Feasibility Report by outside contract.

Project Authorization and Implementation Sequence



⊙ STUDY STAGE OF THE PRESENT PLANNING EFFORT

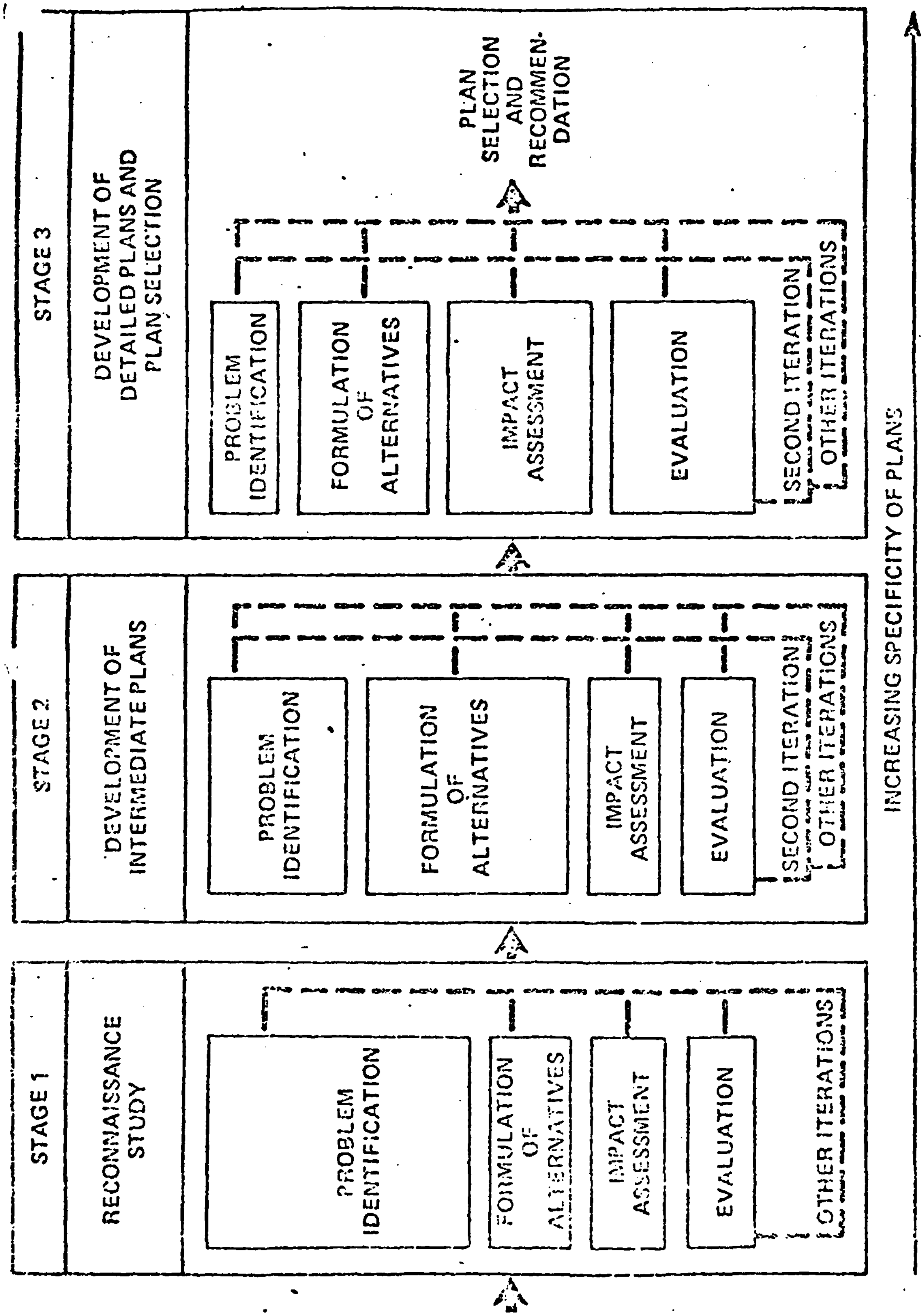


FIGURE 1: GENERAL RELATIONSHIP OF PLAN DEVELOPMENT STAGES AND FUNCTIONAL PLANNING TASKS

GENERAL BACKGROUND INFORMATION

Barge/Tow Activity. A number of biologically adverse impacts are likely to occur as a result of barge/tow operations. The effects of wave wash, sedimentation, resuspension of sediments, noise disturbance, waste and spills have probably already lowered the biological diversity and productivity of areas where it has occurred. Using barge counts (excluding line-haul barges) as an index of such disturbance, the subject parameter grades areas of high existing activity (high barge counts) as more preferable locations for future fleeting than those regions situated away from such activity.

Water Quality. In its water resources investigation of the St. Louis Metropolitan Area (1975), the St. Louis District applied a "River-Eco Model" as a tool for evaluating various water resource alternatives. The study limits of the metro area included a major portion (river miles 148 to 208) of the St. Louis Harbor reach of the Mississippi River. This model was able to compute for the river the time and spatial variations of various water quality and biolgical parameters.

A summary of the model studies findings pertinent to St. Louis Harbor are presented as follows:

(1) Water quality in the St. Louis area is strongly influenced by the conditon of the water as it enters the area from the Missouri and Mississippi Rivers (defined here as the headwaters). These headwaters exhibit strong seasonal variation; however, there is no apparent correlation between the flow rate and water quality.

(2) The headwaters of both the Mississippi and Missouri Rivers contain high oxygen consuming organics (BOD), plant nutrients, total suspended solids, and coliform bacteria.

(3) Local waste discharges in the St. Louis area do not significantly pollute the river within the study area because of the large dilution ratio. However, the mixing of waste and river water may not be complete at some locations on the river, especially near outfalls. Therefore, measurements of BOD, Coliform, temperature and other parameters may be high at these locations.

(4) Model study biomass values for phytoplankton, zooplankton, benthos and fish did not show great variation along the river. The biological effect of waste discharges appeared to be minimal.

(5) With respect to fish, the water appeared to be too warm, too turbid, and too oxygen deficient to support cold water game fish in the summer. The fishery is primarily in the form of warm water fish and scavenger species.

Based on the above findings, it would appear that no generalized biological gradients occur within the harbor area. On a more localized level, incomplete mixing near waste discharge points would suggest that water quality may be limiting to aquatic life. Recognizing that such locally

Incl 2

adverse impacts may occur, the fleeting analysis assumes habitat degradation within subsegments with a relatively higher number of known discharges. Areas that have already been impacted biologically are considered to be less sensitive as areas for future fleeting.

Avian Populations.

Waterfowl. Data describing the actual impacts of tow operations (including fleeting) on waterfowl are essentially non-existent. Nevertheless, some probable areas of impact can be identified.

In the fall, diving ducks will congregate along the river and feed on benthic organisms to rebuild energy reserves for the flight south. Resting and feeding in open water areas is critical to diving ducks, while dabbling ducks, on the other hand, can utilize a greater variety of habitats. The value of feeding areas could be reduced by fleeting associated changes in water turbidity and turbulence resulting in declines in benthic production.

Noise is a factor likely to be deleterious to any species requiring secluded roosting or breeding areas. While waterfowl might at least partially habituate to barge and towboat generated noise, there is presently no data to substantiate this assumption.

Petroleum spills are a potential problem. Such spills can kill waterfowl by coating their bodies or by poisoning. Spills can also impact waterfowl by causing changes in the benthic component of the food chain.

Eagles The major population limiting factors for eagles center around the reproductive stage of their life cycle. Breeding activity rarely occurs within the harbor region. The importance of the harbor to eagles is more as a wintering ground that provides an abundant food source and potential roosting sites. It should be noted that together the states of Illinois and Missouri harbor one of the largest concentrations of wintering eagles to be found anywhere in the United States (Spencer, 1976).

Fish is the preferred item in the eagles wintertime diet (Spencer, 1976). When fish are readily available other food sources are ignored. Fish killed by turbulent water below major impoundments, or from low temperatures and decreased oxygen under snow covered ice may become available in open water areas of the river.

When ice covers and thus limits the presence of open fishing waters, waterfowl, particularly hunter-wounded or crippled birds, may become an important alternative food source. St. Louis Harbor lies within a major travel corridor for migratory waterfowl, and receives a considerable amount of hunting pressure.

Disturbance by the direct presence of humans has been shown to effect the activities of wintering eagles, particularly at feeding areas (Stalmaster and Newman, 1978). Fleeting, as a form of human disturbance, might also represent a potentially adverse effect on eagle feeding. It is also clear that if fleeting was able to seriously disrupt the food chain,

particularly as it relates to the presence of fish and waterfowl, it could also severely impact eagles.

Snow (1973) indicates that although some night roosts are found close to feeding areas, this does not seem to be an essential condition. At Great Salt Lake in Utah where nearby tree cover is lacking, eagles travel 10-15 miles to reach forested sites for roosting. Other factors, such as human disturbance and weather conditions, also influence the selection of roosting locations. Since secluded, topographically diverse forested areas do exist within close proximity to much of the harbor, it does not appear likely that night roosting locations are a serious problem. Fleeting induced retreats from roosting areas would not necessarily result in loss of eagles from the area. In fact, evidence does exist that eagles are capable of establishing new roosting locations once disturbed by humans (Snow, 1973).

Herons. Between the years 1973 and 1977 the Illinois Natural History Survey (INHS) conducted a heron census along the Mississippi River between Cairo, Illinois (River Mile 0) and St. Louis, Missouri, (River Mile 176). The maximum number of nesting colonies found for any one year within this river reach was three for the great blue heron, three for the great egret, two for the black-crowned night heron, one for the little blue heron and one for the cattle egret. During the census period, the population trend for all herons was downward, with only one colony (Great Blue Heron) being present in 1977 (Grabber, 1977). Although no formal surveys have been conducted since 1977, there is no evidence that colonies have existed near the harbor since that time.

The Waterways Experiment Station (WES) in a recent aerial survey of waterbird colonies along the Upper Mississippi River found a similar pattern of decline for herons (Thompson and Landin, 1978).

Interpretation of changes in heron population levels is quite difficult; a considerable degree of natural variation in numbers is known to be possible, but long-term data on the percise nature and significance of such fluctuations is absent. Concern over the viabilit/ of heron populations has prompted Illinois to include the great egret, little blue heron and black-crowned night heron on the state's list of endangered species (IDOC, 1979).

WES, in its survey of the upper river, identified a number of factors that could influence colony site selection for great blue herons and great egrets (the most frequent colonizers in the Upper Mississippi River and based, on Natural History Survey data, also the most frequent in the St. Louis to Cairo river reach). Human disturbance was one of the key items mentioned by WES, and barge operations were specifically cited as a component of this disturbance that herons and egrets tend to avoid. Fleeting operations, by its disturbance of nesting, feeding and other life support areas, could potentially impact the desirability of an area for heron breeding.

Based on present state-of-the-art-knowledge, it cannot be said that a colony site once abandoned ~~by~~ because of fleeting would result in either a change of nesting locale or a population loss. Because of our current state of ignorance, a "better safe than sorry" approach to decision making would seem to be in order. In practical terms, this would mean restricting fleeting operations from areas in close proximity to active or recently active rookery locations.

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9. U.S. Army Corps of Engineers. 1975. Draft Supplement Environmental Statement, Lock and Dam No. 26 (Replacement). Vol. III, St. Louis, MO.

APPENDIX B

COORDINATION CORRESPONDENCE

AGENCIES CONTACTED IN COORDINATION EFFORTS

U.S. Fish and Wildlife Service - Joe Janecek

U.S. Coast Guard - Cpt Walton

U.S. Environmental Protection Agency, Region V - Barbara Taylor

U.S. Environmental Protection Agency, Region VII - Dr Camin

Illinois Department of Conservation - Bob Schanzle

Illinois Department of Transportation - John Puricelli

Missouri Department of Conservation - Norm Stuckey

Missouri Highways and Transportation Department - Sam Masters

Missouri Department of Natural Resources - Howard Markus

Port of Metropolitan St. Louis Advisory Council - Wayne Weidemann

LMSED-BA 23 December 1980

Just recently the District cancelled an 18 December 1980 scoping meeting for the St. Louis Harbor Study. In lieu of this meeting, the District has elected to request written comments from agencies regarding the contracted work effort at Versar, Inc. Comments should be submitted by 2 January 1981, and directed toward (1) a review of Versar's final report on the biological sensitivity analysis of the harbor sites and (2) a review of the Inclosure 1 changes made to the scope of work presented at the 26 September 1980 scoping meeting. Changes made to the scope resulted from agency comments and from casting difficulties that necessitated simplifying the acreage determination procedure and a reallocation of the workload such that data for three of the analysis parameters will be provided to Versar by the Corps.

If your agency has any specific questions regarding the Versar work effort, please feel free to contact Carey Burch at Versar, Inc., at telephone (703) 750-3000 or Dave Gates of the District office at telephone (314) 263-5148.

Sincerely,

SIGNED

ARTHUR L. JOHNSON
Acting Chief, Engineering Division

1 Incl
As stated

Ecological Services
250 West Cherry Street
Carbondale, IL 62901

January 8, 1981

Jack Niemi
Chief Engineering Division
St. Louis Corps of Engineers
210 Tucker Blvd., North
St. Louis, MO 63101

Dear Mr. Niemi:

This responds to the St. Louis District, Corps of Engineers request for comments on (1) Versar's final report on the biological sensitivity analysis at the harbor sites, St. Louis Harbor Study and (2) a review of the Scope of Work "The Identification of Biologically Sensitive Harbor Areas".

The Final Report submitted by Versar should prove to be a valuable reference in future planning for the St. Louis Harbor area.

We believe the Scope of Work enclosed with your letter will also generate a document which will be a valuable reference. We would, however, like to recommend one minor change: that wetland types be classified according to Classification of Wetlands and Deepwater Habitats of the United States. This classification system was published in December 1979 and supersedes the older U.S. Fish and Wildlife Circular 39 system.

Thank you for the opportunity to work with you in planning for future development in the St. Louis Harbor Area.

Sincerely,

Joseph Janecek
Field Supervisor

cc: IL DOC (Cochran)
MO DOC (Stuckey)
Versar (Burch)

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS:
P.O. Box 180
Jefferson City, Missouri 65102

STREET LOCATION:
2901 North Ten Mile Drive
Jefferson City, Missouri 65101

Telephone 314/751-4115
LARRY R. GALE, Director

January 16, 1981

Mr. Jack Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North Tucker Boulevard
St. Louis, Missouri 63101

Re: LMSED-BA

Dear Mr. Niemi:

Thank you for the December 29, 1980 letter requesting comments on (1) Versar's final report on the biological sensitivity analysis of the 29 alternative harbor sites; and (2) the scope of work entitled, "The Identification of Biologically Sensitive Harbor Areas."

We have no additional comments to make on either of these documents. The information generated should be valuable in planning for future development within the St. Louis Harbor area.

We appreciate the opportunity to work with you in this effort.

Sincerely,

Larry R. Gale

LARRY R. GALE
DIRECTOR

COMMISSION

JAY B. DILLINGHAM, *Chairman*
~~Rm. 926~~, Livestock Exchange Bldg.
1600 Genesee
Kansas City 64102

ROY W. JORDAN, *Vice Chairman*
7635 Forsyth Blvd.
Clayton 63105

A. C. RILEY, *Member*
701 Davis
New Madrid 63869

ROY H. GOODHART, *Member*
P. O. Box 877
Hannibal 63401

CARL E. YATES, *Member*
1436 South Glenstone
Springfield 65804

EUGENE J. FELDHAUSEN, *Member*
Suite 430
10920 Ambassador Drive
Kansas City 64153

MISSOURI
HIGHWAY AND TRANSPORTATION COMMISSION

ROBERT N. HUNTER, *Chief Engineer*

BRUCE A. RING, *Chief Counsel*

L. V. MCLAUGHLIN, *Ass't. Chief Engineer*

MRS. IRENE WOLLENBERG, *Secretary*

P. O. Box 270
Jefferson City, Missouri 65102
Telephone (314) 751-2551

June 10, 1981

TRANSPORTATION
Waterways
Comments - Versar's Draft Report
Biologically Sensitive Harbor Areas

Jack R. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 Tucker Boulevard, North
St. Louis, Missouri 63101

Dear Mr. Niemi:

We wish to make the following comments prior to the scheduled coordination meeting for the above subject on June 24.

The reference, on page 4-22, to the site located at Glen Park and lower Sulphur Springs in Missouri appears incorrect. We feel this site number should be 9R instead of 9L.

The reference to this Department in Appendix B is incorrect. It should read Missouri Highway and Transportation Department.

We appreciate the opportunity to comment on this report and will await a copy of the final product.

Very truly yours,

Robert N. Hunter

Chief Engineer

Versar inc.

SAMPLE LETTER

<u>SUMMARY OF 24 JUNE 1981 SCOPING MEETING</u>

I wish to thank you for your participation in the scoping meeting on Wednesday, 24 June 1981. The comments discussed during the meeting regarding the draft biological sensitivity analysis of fleeting in the St. Louis Harbor will enable Versar to provide the Corps with a clearer, more useful study. A list of participants is enclosed. A brief summary of the major comments are given below. These comments will be reflected in the final report.

- The main comment was the need to clarify the objectives of the study. Throughout the report it should be made clear that the intent is to provide an information base as input into future decision-making. The report is not intended to be a site selection or identification tool, although it will be useful to business interests through the identification of biologically sensitive areas.

- The 1-10 scales used for the dredging volume, dredging frequency, barge activity, and water quality parameters need to be altered to reflect the skewed nature of the parameter values. The present scales utilize equal intervals over the entire range of each set of values, resulting in a broad scale which lacks resolution in the lower ranges.

- The example in Section 5.1.8 utilizing a final site rank of 7 as an arbitrary break-off point should be deleted. The results of the study (per the main comment) should provide information along a continuum for decision-making purposes, and does not provide a basis for individual site selection or rejection.

- The avian subparameter weights submitted by the USFWS have been switched in Table 3 for waterfowl and eagles.

P.O. BOX 1549 6621 ELECTRONIC DRIVE, SPRINGFIELD, VIRGINIA 22151 TELEPHONE (703) 750-3000

Versar inc.

- As most spills occur during transfer operations, the term barge spills should be changed to harbor spills.
- As wave action from barge tow traffic may be considered negligible, the term wave wash should be changed to propellor wash.
- The location of replacement Lock and Dam No. 26 needs to be verified.
- The possible implied use of dilution as a means of controlling pollution in Section 3.5.7 should be deleted.
- Other minor wording changes, most of which reflect the main comment.

Again, thank you for your participation in the review of the draft report. If you have any other comments to make on the draft, please contact me as soon as possible.

Sincerely,

Carey W. Burch, AICP
Project Manager

CWB:plg
Attach.

Versar inc.

ST. LOUIS HARBOR FLEETING
IDENTIFICATION OF BIOLOGICALLY SENSITIVE HARBOR AREAS
24 JUNE 1981 MEETING TO REVIEW DRAFT REPORT

Participants	Agency
Tom Crause	Illinois Department of Conservation
Rich Rodakowski	U.S. Army Engineer District, St. Louis
Capt Dick Walton	U.S. Coast Guard
Chuck Franco	U.S. Army Engineer District, St. Louis
Norm Stucky	Missouri Department of Conservation
Rich Wehnes	Missouri Department of Conservation
Bruce Yurdin	Illinois Environmental Protection Agency
George A. Clapp	U.S. Army Engineer District, St. Louis
John Puricelli	Illinois Department of Transportation
Jim Hooper	U.S. Environmental Protection Agency
Elaine Rybak	U.S. Fish and Wildlife Service
Bob Schanzle	Illinois Department of Conservation
Larry Sims	Missouri Highway & Transportation Dept.
Wayne Weidemann	Bi-State Development Agency
Owen D. Dutt	U.S. Army Engineer District, St. Louis
Carey W. Burch	Versar, Inc.
David Gates	U.S. Army Engineer District, St. Louis

APPENDIX C

AQUATIC AND SHORELINE TERRESTRIAL HABITAT TYPES

APPENDIX C

AQUATIC AND SHORELINE TERRESTRIAL HABITAT TYPES

AQUATIC HABITAT TYPES

Main Channel

The main channel is defined as the navigable portion of the river, with water depths of 9 feet or greater. The border for this habitat type will be approximated using the 10-foot contour lines (LWRP) indicated on the hydrographic maps provided.

Main Channel Border

This habitat is defined as the region of the Mississippi River that extends between the main channel and the main banking of the river. A normal stage bankline will be approximated by a line averaging the shorelines depicted by 6 April 1975 aerial photos taken at a high water stage of 20.7' St. Louis Gage and 13 October 1979 photos taken at a low water stage of 3.5' St. Louis Gage.

Backwaters

These include departures from the main river that are still connected to the river during normal river stage. The normal stage shoreline will be determined in the same manner as that described for the main channel border.

Tributaries

Tributary rivers and creeks will be included in this category. The extent of their inclusion landward from the main river is one-quarter mile.

Tailwaters

These include the main channel, main channel border, and other areas immediately below dams which are affected by turbulence during the passage of water through the gates of the dam and out of the locks. An arbitrary lower boundary will be set at a distance of one-half mile below the dam.

SHORELINE TERRESTRIAL HABITAT TYPES

Forested Lands

Areas associated with communities of forest or brushland. Open areas larger than 1.0 acre within a general forest boundary will be delineated.

Open Lands

Areas devoted to annual crops, pasture, old field, and landscape nurseries. Marsh lands are included in this category if they exhibit characteristics of agricultural use.

Developed Lands

Open areas which exhibit the following characteristics: (1) dominated by industrial or commercial types of buildings or activities; (2) showing signs of earth-moving activities (including roads, highways and railroads and their consequent cuts and fills, coal terminals, gravel pits, marinas, and industrial buildings); or (3) occupied by residences and related features such as lawns and woodlots along with residential streets.

Wetlands

This habitat includes wetlands which are part of the riverine system of wetlands classified by the U.S. Fish and Wildlife Service in Classification of Wetlands and Deepwater Habitats (Cowardin, *et al.*, 1979). Lakes and ponds are also included as part of wetlands.

APPENDIX D

SAMPLE COMPUTATION SHEETS

FORM A - COMPUTATION SHEET FOR DETERMINING THE AQUATIC HABITAT VALUE

HABITAT TYPE	HABITAT WEIGHT	UNWEIGHTED RATING						WEIGHTED RATING					
		L	R	L	R	L	R	L	R	L	R	L	R
Main Channel													
Main Channel Border													
Backwaters													
Tributaries													
Tailwaters													
							Aquatic Habitat Value						

L = Left Bank Subsegment
R = Right Bank Subsegment

Procedure:

1. The habitat weights are determined using "the Ranked Pairwise Comparison Technique."
2. The unweighted rating is obtained by dividing the area of a specific habitat type by the total area of the subsegment.
3. The habitat weight and the unweighted ratings are multiplied together to give the weighted rating for each harbor subsegment.
4. The sum of the weighted ratings for each subsegment determines the aquatic habitat value for each subsegment.

FORM B - COMPUTATION SHEET FOR DETERMINING THE SHORELINE TERRESTRIAL HABITAT VALUE

HABITAT TYPE	HABITAT WEIGHT	UNWEIGHTED RATING						WEIGHTED RATING					
		L	R	L	R	L	R	L	R	L	R	L	R
Forested Lands													
Open Lands													
Developed Lands													
Wetlands													
		Shoreline Terrestrial Habitat Value											

L = Left Bank Subsegment
R = Right Bank Subsegment

<u>Procedure:</u>

1. The habitat weights are determined using "the Ranked Pairwise Comparison Technique."
2. The unweighted rating is obtained by dividing the area of a specific habitat type by the total area of the subsegment.
3. The habitat weight and the unweighted ratings are multiplied together to give the weighted rating for each harbor subsegment.
4. The sum of the weighted ratings for each subsegment determines the aquatic habitat value for each subsegment.

FORM C - COMPUTATION SHEET FOR DETERMINING THE AVIAN POPULATION VALUE

PARAMETER	PARAMETER WEIGHT	UNWEIGHTED RATING						WEIGHTED RATING					
		L	R	L	R	L	R	L	R	L	R	L	R
Waterfowl													
Eagles													
Herons													
Avian Population Value													

L = Left Bank Subsegment
R = Right Bank Subsegment

Procedure:

1. The parameter weights are determined using "the ranked pairwise comparison technique."
2. Unweighted 1-10 scale ratings are determined according to the instructions of Section 4c(7) of the scope of work.
3. The parameter weight and the unweighted ratings are multiplied together to give the weighted rating for each harbor subsegment.
4. The sum of the weighted ratings for each subsegment determines the Avian population value for each subsegment.

FORM D - COMPUTATION SHEET FOR BIOLOGICAL SENSTIVITY ANALYSIS

	PARAMETER	PARAMETER WEIGHT	UNWEIGHTED RATING						WEIGHTED RATING					
			L	R	L	R	L	R	L	R	L	R	L	R
1	Aquatic Habitat													
2	Shoreline Terrest Habitat													
3	Dredged Material Discharge													
4	Dredging Frequency													
5	Barge Activity													
6	Water Quality													
7	Avian Populations													
	Biological Sensitivity Value													
	1-10 Scale Rating													

L = Left Bank Subsegment
R = Right Bank Subsegment

<u>Procedure:</u>
(1) The parameter weights are determined using "the ranked pairwise comparison technique."
(2) The unweighted ratings are generated by converting the parametric values obtained in Section 4c of the scope of work into 1-10 scale values. Note that parameters 1, 2 and 7 are "positive" factors while parameters 3, 4, 5 and 6 are "negative" factors. The scale will be applied to the raw data in such a way that the most biologically favorable parameter conditions are reflected by the "5" end of the scale. A value of "1" indicates least favorable conditions.
(3) The parameter weight and the unweighted ratings are multiplied together to give the weighted rating for each harbor segment.
(4) The sum of the weighted ratings for each subsegment determines the biological sensitivity value of the subsegment.
(5) The biological sensitivity value will be converted to a 1-10 scale rating. The higher this final rating, the more biologically sensitive the subsegment.

APPENDIX E

AGENCY INPUT TO PARAMETER AND SUBPARAMETER WEIGHTS

U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service
Missouri Department of Conservation
Illinois Department of Conservation

INPUT FROM ARMY CORPS OF ENGINEERS

ASSIGNMENT OF Final Analysis FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	Aquatic Habitat	1111111									7	0.25
B	Shoreline Terres. Hab.	0	111111								6	0.22
C	Dredge Spoil Discharge	0	0	0.5 0001							1.5	0.05
D	Dredging Frequency	0	0	0.5	0001						1.5	0.05
E	Barge Activity	0	0	1	1	0.5 11					4.5	0.16
F	Water Activity	0	0	1	1	0 5	11				4.5	0.16
G	Avian Populations	0	0	1	1	0	0	1			3	0.11
H												
I												
J	(Dummy)	0	0	0	0	0	0	0			0	0.00
										GRAND TOTAL	28	1.00

Procedure:

* 1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

* Importance was based on the degree to which each parameter measures biological sensitivity of an area to fleeting impacts.

RATIONALE FOR WEIGHTING OF PARAMETERS FOR FINAL SENSITIVITY ANALYSIS

Aquatic Habitat. Since most of the impacts of fleeting have been identified for the main channel border and backwater areas, the aquatic habitat parameter would appear to be the single most comprehensive factor describing the sensitivity of harbor areas to fleeting. This parameter was given a weighted value of 0.25.

Shoreline Terrestrial Habitat. While this parameter is also comprehensive, its relationship to the impacting elements of fleeting seems less significant than it does for the Aquatic habitat. A weighted value of 0.22 was assigned.

Barge Activity and Water Quality. Less comprehensive than the habitat factors, these two parameters were given coequal ratings of 0.16 each. Both factors are assumed to indicate areas of highly disturbed habitat with lower biological sensitivity to fleeting.

Areas of existing barge activity are presently being subjected to most of the probable disturbance factors alluded to elsewhere in the rationale. Water quality disturbance is expected primarily in areas of waste discharge outfalls where the mixing of waste and river water may not be complete.

Avian Populations. Waterfowl, eagle and heron populations are clearly important, and moderate levels of fleeting induced impacts to these populations can be expected. This parameter has been given a weighting value of 0.11.

Dredge Spoil Discharges and Dredging Frequency. These two parameters were also rated as coequals (rating 0.05). The value of these two paramenters together would approximate the importance of the individual parameters of barge activity and water quality as indicators of disturbed habitat conditions.

The degradational effect of dredging operations has been demonstrated for the Middle River. Both diversity and abundance of benthic organisms occuring in main channel border areas previously affected by disposal operations are low when compared to similar areas with no disposal history.

ASSIGNMENT OF Aquatic Habitat FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	Main Channel	00001									1	0.07
B	Main Channel Border	1	1111								5	0.33
C	Backwaters	1	0	111							4	0.27
D	Tributaries	1	0	0	11						3	0.20
E	Tailwaters	1	0	0	0	1					2	0.13
F												
G												
H												
I												
J	(Dummy)	0	0	0	0	0					0	
										GRAND TOTAL	15	1.00

Procedure:

*1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

* Habitat importance was based on both the perceived value of the habitat and the degree to which it would be impacted by fleeting.

AD-A130 599 A BIOLOGICAL SENSITIVITY ANALYSIS OF FLEETING FOR THE PORT OF METROPOLITA..(U) VERSAR INC SPRINGFIELD VA C W BURCH ET AL. 17 JUL 81 DACW43-80-D-0025 2/2

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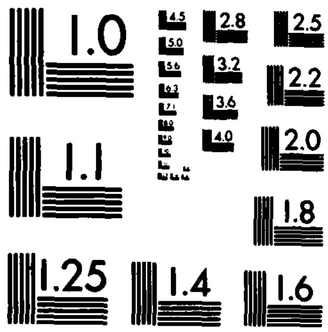

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

RATIONALE FOR WEIGHTING OF AQUATIC HABITAT SUB-PARAMETERS

Assignment of the aquatic habitat importance weights was accomplished by considering: (1) the perceived biological value of the habitat, and (2) the perceived degree to which the habitat would be impacted by the action of fleeting.

Main Channel Border. Although probably not as important as backwater habitat, the main channel border does provide essential nursery and spawning areas within the river proper. The diversity of this habitat for fish and benthos is much higher than that of the main channel. The channel border is also important for the resting and feeding of water-associated birds.

Metals resuspended from bottom sediments during fleeting operations may not be a problem. Hardwater areas such as the middle river, do not readily pass metals into solution. However, low concentrations of resuspended organic toxicants could enter the water column, but as yet no general statements regarding the biological implications of such an effect can be made.

Tow traffic movement on the Mississippi River (Upper River) has been demonstrated to increase turbidity to above ambient levels during normal pool conditions. Decreased primary productivity is an impact likely to result from this increased turbidity; however, this and other effects on large river biota are not yet well understood.

Once sediment particles begin to settle, other problems may occur. Sediment may disrupt normal fish reproduction by covering spawning grounds or eggs, or prevent the emergence of newly hatched fry. Suspended solids can also alter the faunal composition, numbers, densities and species diversity of invertebrate populations.

The potential for accidental spillage of pollutants poses a substantial ecological threat to the main channel border habitat. Spills of toxic chemicals such as petroleum are likely to have the most serious impacts. When light oils become emulsified in water they are highly poisonous to fish, shellfish, benthos and other aquatic organisms. Water-associated birds and mammals may also be directly poisoned. Heavier weight oils may cover reptiles, birds and mammals resulting in death.

Fleeting has certain other implications for terrestrial organisms. Amphibians and reptiles nesting at shoreline locations may be seriously impacted by wave action; young muskrats and beaver could be vulnerable within their river bank dens. Fleeting induced alteration of the food chain may impact the feeding of waterfowl, eagles and herons. Disturbance related to noise and the physical presence of barges and tows may have impacts on the feeding, resting and breeding of waterfowl and herons, and on the feeding and roosting of eagles.

High habitat value and a high degree of vulnerability to fleeting impacts ranks this sub-parameter quite high. A rating of 0.33 was assigned.

Backwaters. Backwaters have been shown to provide very important nursery, spawning, and feeding areas for fish. Side channels, for instance, contain numerous fish and food chain components not found in main channel border areas. The productivity of backwaters is quite high, and these areas are important to the breeding and feeding of water-associated birds and furbearers.

Probable impacts to this habitat are essentially the same as those described for the main channel border; the chief difference is in the magnitude of the impacts. Backwaters would generally be further removed and thus somewhat more isolated from the physical effects of fleeting.

The high importance of this habitat, and its moderate degree of susceptibility to fleeting disturbance, ranks this sub-parameter relatively high. A weighting of 0.27 was assigned.

Tributaries. This habitat in itself contains components of main channel, main channel border and backwaters. Such highly diverse habitat is expected to yield a high diversity of species. Tributaries can be important as spawning and nursery areas.

Very little impact would be expected for this area since the effects of fleeting would be countered by the effect of tributary water flowing into the river proper.

Moderate to high habitat value and low susceptibility to fleeting impacts yields a sub-parameter weighting of 0.20.

Tailwater. Although tailwaters represent a high quality habitat, their rather limited and artificial nature tend to rank them much lower. Tailwaters below dams can be important as winter fishing areas for bald eagles.

Noise and the physical presence of fleeting in areas of tailwaters might adversely affect the feeding pattern of any eagles present. The deep water and high turbulence of tailwaters would probably largely minimize any potential effects of wave wash, sedimentation or the resuspension of sediment caused by fleeting. A weighting of 0.13 was given to this moderately important, low vulnerability habitat type.

Main Channel. This habitat is presently highly disturbed by navigation. Ecologically the area has low species diversity and species that are present exhibit wide ecological tolerance. Fish feeding and spawning is not significant in this area and benthos populations are relatively low. Occasional usage of the habitat by waterfowl has been observed.

Bottom turbulence, waves, and resuspended sediments generated by fleeting activities and normal barge traffic would not be expected to have a significant biological impact on this already disturbed and essentially sterile habitat.

Low habitat importance and a low degree of susceptibility yields a weighted value for this sub-parameter of 0.07.

ASSIGNMENT OF Shoreline Terrestrial Habitat FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	Forested Lands	1111									4	0.40
B	Open Lands	0	101								2	0.20
C	Developed Lands	0	0	01							1	0.10
D	Wetlands	0	1	1	1						3	0.30
E												
F												
G												
H												
I												
J	(Dummy)	0	0	0	0						0	0.00
										GRAND TOTAL	10	1.00

Procedure:

* 1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

* Habitat importance was based on both the perceived value of the habitat and the degree to which it would be impacted by fleeting.

RATIONALE FOR WEIGHTING OF SHORELINE TERRESTRIAL HABITAT SUB-PARAMETERS

The assignment of the terrestrial habitat weights was accomplished by considering the perceived importance of each habitat type, as well as the perceived degree to which that habitat is expected to be impacted by fleeting.

Forested lands. This is a diverse and highly productive habitat type, providing a great number of available nitches. Loose bark, tree forks, tree cavities, stumps, hollow logs and ground depressions provide cover and breeding habitat for many vertebrates. Abundant fruits, seeds, leaves, twigs, invertebrates and other animals provide an important food source for wildlife. When flooded, forested habitat can also provide spawning and feeding sites for fish.

Wave wash caused by fleeting along unrevetted shorelines could eliminate at least some vegetative sources of food and shelter for terrestrial vertebrates. Willows, the trees that would be most affected by wave wash, are already well adapted to the harsh conditions of the natural river and would thus not be expected to be impacted significantly. However, increased wave action would be expected to diminish certain shallow rooted herbaceous plants.

Human disturbance via noise and the physical presence of fleeting activity could potentially disturb the nesting sites of herons or the roosting sites of eagles. Destruction of forest habitat could also occur if the presence of the fleeting area is attractive to the development of on-bank harbor facilities.

The high importance and moderate impact vulnerability of this habitat type places it at the highest position relative to the other terrestrial habitat sub-parameters. A rating of 0.40 was assigned.

Wetlands. Many of these areas are intermittent and thus do not support extensive aquatic plant communities. The habitat can be important to foraging bats, beaver, muskrat, and to migrating waterfowl seeking resting and feeding areas. Numerous reptiles and amphibians use the area for feeding and breeding.

During high water periods, when the river is in contact with many wetlands, these areas would be subject to fleeting associated spills. Oil spills could impact waterfowl by directly covering or poisoning the birds, or indirectly by impacting the benthos component of the food chain.

It is doubtful that fleeting causes significant quantities of suspended sediments to reach wetlands at high water stage; this is because at this stage the barges and towboats are high above the channel bottom.

The moderate importance and moderate susceptibility of the habitat type to impacts ranks wetlands as the next most significant factor. A weighting of 0.30 was assigned.

Open lands. The prime importance of agricultural land to wildlife is as a source of food. When inundated by water, these lands attract many birds (e.g. herons) not usually found in this habitat.

Fleeting induced land development is perceived as the major potential impact to this habitat type. Habitat loss through the action of wave wash is seen as a very minor impact. Noise effects generated by barges and towboats could cause a generalized disturbance to wildlife.

Moderate to low habitat value and a relatively low vulnerability to fleeting impacts yield a weighted value of 0.20.

Developed land. These lands are of very little importance to wildlife and impacts to this habitat by fleeting would be negligible. A weighted value of 0.10 was assigned to this sub-parameter.

ASSIGNMENT OF Avian Populations FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	Waterfowl	0.5 0.5 1									2	0.33
B	Eagles	0.5	0.5 1								2	0.33
C	Herons	0.5	0.5	1							2	0.33
D												
E												
F												
G												
H												
I												
J	(Dummy)	0	0	0								
										GRAND TOTAL	6	.99

Procedure:

* 1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

* Importance was based on both the perceived value of the resource and its susceptibility to the impacts of fleeting.

RATIONALE FOR WEIGHTING OF AVIAN POPULATION SUB-PARAMETERS

All three sub-parameters (i.e. waterfowl, eagles and herons) are considered to be highly important and moderately susceptible to fleeting impacts. Co-equal weightings of 0.33 were assigned to each.

The primary significance of the harbor to eagles is not for breeding purposes, but as a wintering ground providing a source of food and roosting sites. Fleeting activities affecting the production or availability of fish and waterfowl as food items could impact eagles. Impacts to eagle roosting locations could also occur; however, there is evidence that eagles are capable of establishing new roosting locations. Several of the heron species are on the Illinois state list of endangered species and impact to feeding and particularly to nesting areas is a likely possibility. Moderate fleeting induced impacts to the feeding and resting of waterfowl, particularly of diving ducks, are expected. Petroleum and other types of spills could impact waterfowl directly by covering or poisoning the birds, or indirectly via impacts to the food chain.

GENERAL BACKGROUND INFORMATION

Barge/Tow Activity. A number of biologically adverse impacts are likely to occur as a result of barge/tow operations. The effects of wave wash, sedimentation, resuspension of sediments, noise disturbance, waste and spills have probably already lowered the biological diversity and productivity of areas where it has occurred. Using barge counts (excluding line-haul barges) as an index of such disturbance, the subject parameter grades areas of high existing activity (high barge counts) as more preferable locations for future fleeting than those regions situated away from such activity.

Water Quality. In its water resources investigation of the St. Louis Metropolitan Area (1975), the St. Louis District applied a "River-Eco Model" as a tool for evaluating various water resource alternatives. The study limits of the metro area included a major portion (river miles 148 to 208) of the St. Louis Harbor reach of the Mississippi River. This model was able to compute for the river the time and spatial variations of various water quality and biolgical parameters.

A summary of the model studies findings pertinent to St. Louis Harbor are presented as follows:

(1) Water quality in the St. Louis area is strongly influenced by the conditon of the water as it enters the area from the Missouri and Mississippi Rivers (defined here as the headwaters). These headwaters exhibit strong seasonal variation; however, there is no apparent correlation between the flow rate and water quality.

(2) The headwaters of both the Mississippi and Missouri Rivers contain high oxygen consuming organics (BOD), plant nutrients, total suspended solids, and coliform bacteria.

(3) Local waste discharges in the St. Louis area do not significantly pollute the river within the study area because of the large dilution ratio. However, the mixing of waste and river water may not be complete at some locations on the river, especially near outfalls. Therefore, measurements of BOD, Coliform, temperature and other parameters may be high at these locations.

(4) Model study biomass values for phytoplankton, zooplankton, benthos and fish did not show great variation along the river. The biological effect of waste discharges appeared to be minimal.

(5) With respect to fish, the water appeared to be too warm, too turbid, and too oxygen deficient to support cold water game fish in the summer. The fishery is primarily in the form of warm water fish and scavenger species.

Based on the above findings, it would appear that no generalized biological gradients occur within the harbor area. On a more localized level, incomplete mixing near waste discharge points would suggest that water quality may be limiting to aquatic life. Recognizing that such locally

adverse impacts may occur, the fleeting analysis assumes habitat degradation within subsegments with a relatively higher number of known discharges. Areas that have already been impacted biologically are considered to be less sensitive as areas for future fleeting.

Avian Populations.

Waterfowl. Data describing the actual impacts of tow operations (including fleeting) on waterfowl are essentially non-existent. Nevertheless, some probable areas of impact can be identified.

In the fall, diving ducks will congregate along the river and feed on benthic organisms to rebuild energy reserves for the flight south. Resting and feeding in open water areas is critical to diving ducks, while dabbling ducks, on the other hand, can utilize a greater variety of habitats. The value of feeding areas could be reduced by fleeting associated changes in water turbidity and turbulence resulting in declines in benthic production.

Noise is a factor likely to be deleterious to any species requiring secluded roosting or breeding areas. While waterfowl might at least partially habituate to barge and towboat generated noise, there is presently no data to substantiate this assumption.

Petroleum spills are a potential problem. Such spills can kill waterfowl by coating their bodies or by poisoning. Spills can also impact waterfowl by causing changes in the benthic component of the food chain.

Eagles The major population limiting factors for eagles center around the reproductive stage of their life cycle. Breeding activity rarely occurs within the harbor region. The importance of the harbor to eagles is more as a wintering ground that provides an abundant food source and potential roosting sites. It should be noted that together the states of Illinois and Missouri harbor one of the largest concentrations of wintering eagles to be found anywhere in the United States (Spencer, 1976).

Fish is the preferred item in the eagles wintertime diet (Spencer, 1976). When fish are readily available other food sources are ignored. Fish killed by turbulent water below major impoundments, or from low temperatures and decreased oxygen under snow covered ice may become available in open water areas of the river.

When ice covers and thus limits the presence of open fishing waters, waterfowl, particularly hunter-wounded or crippled birds, may become an important alternative food source. St. Louis Harbor lies within a major travel corridor for migratory waterfowl, and receives a considerable amount of hunting pressure.

Disturbance by the direct presence of humans has been shown to effect the activities of wintering eagles, particularly at feeding areas (Stalmaster and Newman, 1978). Fleeting, as a form of human disturbance, might also represent a potentially adverse effect on eagle feeding. It is also clear that if fleeting was able to seriously disrupt the food chain,

particularly as it relates to the presence of fish and waterfowl, it could also severely impact eagles.

Snow (1973) indicates that although some night roosts are found close to feeding areas, this does not seem to be an essential condition. At Great Salt Lake in Utah where nearby tree cover is lacking, eagles travel 10-15 miles to reach forested sites for roosting. Other factors, such as human disturbance and weather conditions, also influence the selection of roosting locations. Since secluded, topographically diverse forested areas do exist within close proximity to much of the harbor, it does not appear likely that night roosting locations are a serious problem. Fleeting induced retreats from roosting areas would not necessarily result in loss of eagles from the area. In fact, evidence does exist that eagles are capable of establishing new roosting locations once disturbed by humans (Snow, 1973).

Herons. Between the years 1973 and 1977 the Illinois Natural History Survey (INHS) conducted a heron census along the Mississippi River between Cairo, Illinois (River Mile 0) and St. Louis, Missouri, (River Mile 176). The maximum number of nesting colonies found for any one year within this river reach was three for the great blue heron, three for the great egret, two for the black-crowned night heron, one for the little blue heron and one for the cattle egret. During the census period, the population trend for all herons was downward, with only one colony (Great Blue Heron) being present in 1977 (Grabber, 1977). Although no formal surveys have been conducted since 1977, there is no evidence that colonies have existed near the harbor since that time.

The Waterways Experiment Station (WES) in a recent aerial survey of waterbird colonies along the Upper Mississippi River found a similar pattern of decline for herons (Thompson and Landin, 1978).

Interpretation of changes in heron population levels is quite difficult; a considerable degree of natural variation in numbers is known to be possible, but long-term data on the percise nature and significance of such fluctuations is absent. Concern over the viability of heron populations has prompted Illinois to include the great egret, little blue heron and black-crowned night heron on the state's list of endangered species (IDOC, 1979).

WES, in its survey of the upper river, identified a number of factors that could influence colony site selection for great blue herons and great egrets (the most frequent colonizers in the Upper Mississippi River and based, on Natural History Survey data, also the most frequent in the St. Louis to Cairo river reach). Human disturbance was one of the key items mentioned by WES, and barge operations were specifically cited as a component of this disturbance that herons and egrets tend to avoid. Fleeting operations, by its disturbance of nesting, feeding and other life support areas, could potentially impact the desirability of an area for heron breeding.

Based on present state-of-the-art-knowledge, it cannot be said that a colony site once abandoned ~~by~~ because of fleeting would result in either a change of nesting locale or a population loss. Because of our current state of ignorance, a "better safe than sorry" approach to decision making would seem to be in order. In practical terms, this would mean restricting fleeting operations from areas in close proximity to active or recently active rookery locations.

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INPUT FROM U.S. FISH AND WILDLIFE SERVICE

United States Department of the Interior

FISH AND WILDLIFE SERVICE

~~ROCK ISLAND FIELD OFFICE (ES)~~
~~1830 SECOND AVENUE~~
~~ROCK ISLAND, ILLINOIS 61201~~

Ecological Services
250 West Cherry Street
Carbondale, IL 62901

IN REPLY REFER TO:

January 28, 1981

Mr. Carey Burch
Versar, Inc.
6621 Electronic Drive
Springfield, VA 22151

Dear Mr. Burch:

Enclosed are the results of the pair-wise comparisions for aquatic and terrestrial habitats, avian populations, and biological analysis; St. Louis Harbor Study. The importance values were assigned after considering the habitats' potential for supporting high species diversity as well as the regional importance a particular habitat may have along the study area of the river. We also considered federal rules and regulations that direct the Fish and Wildlife Service to protect certain types of habitat because of their significant value to fish and wildlife.

As in the previous comparisions, this analysis applies only for the reach of the Mississippi River being considered for further development in the St. Louis Harbor Study. Application of these conclusions for any other purpose may not be valid.

Sincerely,

Alan L. Balliett

for Joe Janecek
Field Supervisor

Enclosure

Rationale for Factor Weight Assignment - Avian Populations

Eagles - Eagles received the highest rating, a value of .42. The bald eagle is listed as endangered in almost all the contiguous states. The Endangered Species Act of 1973 provides for the protection of endangered and threatened species and the conservation of ecosystems on which they depend. Bald eagles winter primarily along the Mississippi River from Twin Cities, Minnesota to the southern tip of Illinois.

Waterfowl - Waterfowl received a rating of .33. Waterfowl are important ecologically as well as economically (sport hunting). A large proportion of Fish and Wildlife Service Programs are directed toward waterfowl production and habitat protection.

Herons - We gave herons a rating very close to waterfowl, .25. Herons are important from an ecological standpoint and are an important part of Fish and Service Programs. They do not, however, have economic values like waterfowl.

Rationale for Factor Weight Assignment - Aquatic Habitat

Tributaries - We rated tributaries at .30 because each contains its own backwaters, main channel, and channel border. The potential for fish and wildlife diversity is high due to the variety of habitats each contains. Also, many tributaries have higher water quality and support a more desirable fishery than found in the main stream.

Backwaters - Backwaters were rated at .27 due to the wide range of aquatic systems included. Vegetation diversity is usually very high and backwaters provide the life requisites for many commercial and sport fish species. In addition, these waters serve as valuable breeding and feeding areas for waterfowl and furbearers.

Tailwaters - This received a rating of .20. Although these areas may be disturbed, they do provide a good fishery and may function as a feeding ground for eagles during certain periods of the year.

Channel Border - Rated .16; main channel borders provide a variety of cover food and general habitat for a diversity of species. Spawning and feeding activity by fish occurs there and the shallower areas may be used by wading birds and waterfowl. This is also the primary habitat for mussels including several threatened and endangered species.

Main Channel - Rated at .07; some habitat for fish feeding and spawning and limited use by waterfowl and other birds. Major drawbacks are the swift current and turbulence caused by commercial navigation.

Rationale for Factor Weight Assignment - Biological Analysis

Aquatic Habitat - Aquatic habitat received a rating of .20 due to the high biological productivity associated with aquatic systems. This habitat supports fish, mussels, some furbearers, waterfowl, and other birds.

Avian Populations - This factor was rated .17. Avian populations include endangered species, such as the bald eagle, which winters in this stretch of the Mississippi River; waterfowl; shore and wading birds; and many songbirds. Protection and production of these species are important U.S. Fish and Wildlife Service objectives.

Water Quality - Water quality was rated .16. Water quality is closely related to the quality of aquatic habitat. It is an important determinant of species diversity and productivity.

Shoreline Terrestrial Habitat - Rated .14, because it includes a great variety of habitats supporting diverse plant and animal communities. In addition, it possesses recreational value for activities such as hunting and fishing.

Dredge Spoil Disposal - We rated this at .14, because spoil disposal displaces natural habitats and biotic commonities. It may be a source of erosion and sedimentation problems. Riverside vegetation is removed or destroyed causing water temperature to rise. However, dredge spoil disposal does create islands which eventually could support food and cover beneficial to some wildlife species.

Barge Activity - Barge activity was rated at .10. Siltation, bank erosion and release of toxic materials from barge washing are all negative impacts associated with barge activity. These impacts are a particular problem in fleeting areas. These shallow water areas (main channel borders) have good biological productivity (mussels in particular) and are adversely affected by barge activities.

Dredging Frequency - Dredging frequency was rated .09. With increased dredging, diversity of water depths is decreased and shallow water areas reduced. The disturbance of organic bed material and the release of nutrients may increase biological oxygen demand. Suspended solids will be increased at the site and downstream. This will eventually result in an increased rate of sediment deposition. Macroinvertebrutes in particular, are displaced with dredging and with increased frequency of dredging, repopulation becomes less likely.

Rationale for Factor Weight Assignment - Terrestrial Habitat

Wetlands - Wetlands received the highest factor weight, a value of .35. Wetlands usually support a rich assortment of emergent and submergent vegetation which in turn provide food and cover for many species of fish and wildlife. Some wetlands are vital to certain fish spawning activities as well as pair formation, nesting and brooding of waterfowl. Wetlands serve valuable water quality functions, such as trapping sediments, filtering nutrients, and protecting shorelines from erosion. The ability of wetlands to store high water is a natural form of flood control. It is estimated that approximately 300,000 acres of wetlands are drained or filled in the U.S. each year. The Fish and Wildlife Service places a high priority on wetland protection.

Forested Lands - Forested lands are rated .30. Mast producing trees have food value for several bird and mammal species and all tree species provide nesting, feeding and perching sites for a wide variety of wildlife. Dead and dying trees of sufficient size provide nests and dens for birds and mammals requiring cavities. Large forest tracts have been cleared and converted to agricultural pursuits thereby increasing the value of the relict habitats remaining. Disappearance of riparian forests has become particularly widespread and all federal agencies are directed by Executive Order 11988 to protect flood plains, including flood plain forests.

Open Lands - We rated open land .25. Intensively cultivated land has little or no wildlife value. Disturbance through planting, cultivating, harvesting, and plowing may not allow wildlife to become established in these areas. However, seasonally flooded grain fields can attract waterfowl. Shelterbelts and fencerows may provide food and cover for some species. Pasture and old fields may support rodent populations used by raptors. Brushy areas provide habitat for a wide variety of species. These areas provide browse for deer, feeding and nesting habitats for songbirds; and in areas near shorelines, brood cover for waterfowl.

Developed Lands - This habitat received a .10 rating because there is little or no food and cover and these areas are highly disturbed by human activity.

ASSIGNMENT OF AQUATIC HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES						SUM	FACTOR WEIGHT
A	MAIN CHANNEL		0.00	0.00	0.00	0.00	1.00	1.00	0.07
B	MAIN CHANNEL BORDER	1.00		0.00	0.00	0.50	1.00	2.50	0.16
C	BACKWATERS	1.00	1.00		0.50	0.50	1.00	4.00	0.27
D	TRIBUTARIES	1.00	1.00	0.50		1.00	1.00	4.50	0.30
E	TAILWATERS	1.00	0.50	0.50	0.00		1.00	3.00	0.20
F									
G									
H									
I									
J	(Dummy)	0.00	0.00	0.00	0.00	0.00		0.00	0.00
							GRAND TOTAL	15.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

ASSIGNMENT OF TERRESTRIAL HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	FORESTED LANDS		0.75	1.00	0.25	1.00					3.00	0.30
B	OPEN LANDS	0.25		1.00	0.25	1.00					2.50	0.25
C	DEVELOPED LANDS	0.00	0.00		0.00	1.00					1.00	0.10
D	WETLANDS	0.75	0.75	1.00		1.00					3.50	0.35
E												
F												
G												
H												
I												
J	(Dummy)	0.00	0.00	0.00	0.00						0.00	0.00
										GRAND TOTAL	10.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

ASSIGNMENT OF AVIAN POPULATION FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

FACTOR		ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	WATERFOWL		0.25	0.75	1.0						2.00	0.33
B	EAGLES	0.75		0.75	1.0						2.50	0.42
C	HERONS	0.25	0.25		1.0						1.50	0.25
D												
E												
F												
G												
H												
I												
J	(Dummy)	0.00	0.00	0.00							0.00	0.00
										GRAND TOTAL	6.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

ASSIGNMENT OF BIOLOGICAL ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES								SUM	FACTOR WEIGHT
A	AQUATIC HABITAT		0.75	0.75	0.75	0.75	0.75	0.75	1.00	5.50	0.20
B	SHORELINE TERR. HABITAT	0.25		0.75	0.75	0.75	0.25	0.25	1.00	4.00	0.14
C	DREDGE SPOIL DISCHARGE	0.25	0.25		1.00	0.75	0.50	0.25	1.00	4.00	0.14
D	DREDGING FREQUENCY	0.25	0.25	0.00		0.50	0.25	0.25	1.00	2.50	0.09
E	BARGE ACTIVITY	0.25	0.25	0.25	0.50		0.25	0.25	1.00	2.75	0.10
F	WATER QUALITY	0.25	0.75	0.50	0.75	0.75		0.50	1.00	4.50	0.16
G	AVIAN POPULATIONS	0.25	0.75	0.75	0.75	0.75	0.50		1.00	4.75	0.17
H											
I											
J	(Dummy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
									GRAND TOTAL	28.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

INPUT FROM MISSOURI DEPARTMENT OF CONSERVATION

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS:
P.O. Box 180
Jefferson City, Missouri 65102

STREET LOCATION:
2901 North Ten Mile Drive
Jefferson City, Missouri 65101

Telephone 314/751-4115
LARRY R. GALE, Director

January 27, 1981

Mr. Carey W. Burch, AICP
Environmental Planning Division
Versar, Inc.
6621 Electronic Drive
Springfield, Virginia 22151

Dear Mr. Burch:

Enclosed are the completed forms to be used in establishing parameter weights needed to complete the St. Louis Harbor Fleeting Study.

Brief comments explaining the rationale used in establishing the parameter weights are attached to each form.

Please contact me if additional input is needed.

Sincerely,

Norman Stucky

NORMAN P. STUCKY
ENVIRONMENTAL COORDINATOR

NPS:jct
Enc.

ASSIGNMENT OF TERRESTRIAL HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES A	B	C	D	J					SUM	FACTOR WEIGHT
A	FORESTED LANDS	—	.25	1	.15	1					2.40	.24
B	OPEN LANDS	.75	—	1	.15	1					2.90	.29
C	DEVELOPED LANDS	0	0	—	0	1					1.0	.10
D	WETLANDS	.85	.85	1	—	1					3.70	.37
E												
F												
G												
H												
I												
J	(Dummy)											
										GRAND TOTAL	10	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

TERRESTRIAL HABITAT

Forested Lands - Valuable for many species of wildlife. Nests, dens, mast are all important factors. Flooded bottomland hardwoods are used extensively by waterfowl during annual migration.

Open Lands - How is this category defined. We viewed it as bottomland which had been cleared and reverting back to natural habitat conditions. Early successional stages,i.e. old fields, are generally more productive than a climax community.

Developed Lands - We included all development including agricultural land in this category. Limited habitat is available for wildlife species. Primary value is the food provided when located adjacent to other habitat requirement.

Wetland - Generally these areas are highly productive due to an abundance of aquatic vegetation. Food and cover are provided for many species of fish and wildlife.

ASSIGNMENT OF AVIAN POPULATION FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
		A	B	C	J							
A	WATERFOWL	-	.60	.60	1						2.20	.37
B	EAGLES	.40	-	.60	1						2.00	.33
C	HERONS	.40	.40	-	1						1.80	.30
D												
E												
F												
G												
H												
I												
J	(Dummy)											
										GRAND TOTAL	6.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

AVIAN POPULATION

I feel little value should be placed on these weights. All these bird species are equally important. Our thinking was probably biased because eagles are rare and most of us are waterfowl hunters. Also there are <u>numerous</u> species of waterfowl as opposed to only several species of eagles and herons.

ASSIGNMENT OF BIOLOGICAL ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	AQUATIC HABITAT	-	.50	1	1	1	.50	.50	1		5.50	.20
B	SHORELINE TERR. HABITAT	.50	-	1	1	1	.50	.50	1		5.50	.20
C	DREDGE SPOIL DISCHARGE	0	0	-	.50	.25	0	0	1		1.75	.06
D	DREDGING FREQUENCY	0	0	.50	-	.25	0	0	1		1.75	.06
E	BARGE ACTIVITY	0	0	.75	.75	-	0	0	1		2.50	.09
F	WATER QUALITY	.50	.50	1	1	1	-	.75	1		5.75	.21
G	AVIAN POPULATIONS	.50	.50	1	1	1	.25	-	1		5.25	.18
H												
I												
J	(Dummy)											
										GRAND TOTAL	28.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

BIOLOGICAL ANALYSIS

This was a tossup depending on whether you're talking to a fisheries or wildlife man. Both Aquatic and Shoreline Terrestrial Habitat are important for fish and wildlife species. Neither Dredge Spoil Discharge nor Dredging Frequency are of value to an aquatic ecosystem. Turbulence, spills and barge cleaning are related Barge Activities which adversely impact the aquatic environment. Water Quality is extremely important for the well-being of all organisms including man. Avian Populations will be present if the habitat is preserved.

ASSIGNMENT OF AQUATIC HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	A	B	C	D	E	J				SUM	FACTOR WEIGHT
		ASSIGNMENT OF IMPORTANCE VALUES										
A	MAIN CHANNEL	—	0	0	0	0	1				1	.06
B	MAIN CHANNEL BORDER	1	—	0	.25	.25	1				2.50	.17
C	BACKWATERS	1	1	—	.75	.75	1				4.50	.30
D	TRIBUTARIES	1	.75	.25	—	.75	1				3.75	.25
E	TAILWATERS	1	.75	.25	.25	—	1				3.25	.22
F												
G												
H												
I												
J	(Dummy)											
										GRAND TOTAL	15.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
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6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

AQUATIC HABITAT ANALYSIS

Main Channel - Available information indicates that due to velocity, suspended sediments, and moving bedload, the main channel provides limited habitat for aquatic organisms.

Main Channel Border - This area is characterized by more diversity - varying depth and velocity, relatively stable substrate, rooted vegetation, less turbulence - which is essential for aquatic ecosystem productivity.

Backwaters - Very productive due to stable diverse habitat conditions.

Tributaries - Important as fish spawning and nursery areas.

Tailwaters - Generally provide an excellent fishery. Open water and availability of food attracts eagles and waterfowl during winter months.

INPUT FROM ILLINOIS DEPARTMENT OF CONSERVATION

Illinois Department of Conservation
life and land together

605 WM. G. STRATTON BUILDING • 400 SOUTH SPRING STREET • SPRINGFIELD 62706
CHICAGO OFFICE – ROOM 100, 160 NO. LASALLE 60601
[illegible]

February 6, 1981

Mr. Carey Burch
Versar, Inc.
6621 Electronic Drive
Springfield, Virginia, 22151

Dear Carey:

Attached is our input to the factor weighting for the draft St. Louis Harbor Fleeting Study - The Identification of Biologically Sensitive Areas.

I hope we have not delayed you too much with our slow response to your January 19 letter.

Please contact me if you have any questions about the values we assigned to the various parameters.

Sincerely,

Robert W. Schanzle
Permit Program Manager
Division of Planning

RWS:ph
Attachment

AQUATIC HABITAT ANALYSIS WEIGHTING

Main Channel - Though used by fish and other aquatic life to some extent, the main channel does not generally support spawning or nursery areas, mussel beds, etc., and thus is less susceptible to fleeting related disturbances. It is considered of lesser value than the other aquatic types.

Main Channel Border - Very important as habitat for most types of fish and benthos, and the most productive area in the river proper. It is also very susceptible to fleeting related disturbances (e.g. dredging, prop wash) and is rated highly.

Backwaters - These include chutes, side channels, etc. which have been shown to be of major importance to the overall productivity of the river system. Though not susceptible to direct fleeting disturbances other than at their points of connection to the main stem of the river, they are rated highly.

Tributaries - Tributaries may be important as spawning and nursery areas, in nutrient input to the river system, and as sources of forage fishes. They are susceptible to fleeting disturbances at their mouths and are highly rated.

Tailwaters - While these are productive areas for fish, they are related to artificial disturbance to the river (dams). Since they are probably not suitable locations for fleeting, they are not rated highly for this weighting.

TERRESTRIAL HABITAT ANALYSIS WEIGHTING

Though none of the three habitat types (forested, open, wetland) is probably more susceptible to fleeting related disturbances than the others, wetlands are rated more highly because they are considered the most diverse of the three types. Given a choice, we would prefer to see a fleet established adjacent to an open field or woods rather than a wetland.

For purposes of this ranking, developed lands are considered to have almost no habitat value. "Open lands" presumably includes old fields and brushy areas which may have considerable value as habitat.

AVIAN POPULATION WEIGHTING

This was a difficult category to assign weights to because each of the three avian groups is considered quite important. However, eagles are probably limited to fewer major use areas and they are a federally endangered species (some herons and waterfowl are on the state list). Thus, they were given a higher rating.

BIOLOGICAL ANALYSIS WEIGHTING

Aquatic Habitat	-	This is considered one of the most important categories in this ranking. While shoreline habitat is also quite important, it is probably less susceptible to fleeting-related disturbance and is thus ranked somewhat lower. Of all factors that might be used to determine a non-acceptable location for a fleet, aquatic habitat is most important from our standpoint.
Shoreline Terrestrial Habitat	-	See above.
Dredge Spoil Discharge	-	This category, along with "dredging frequency" and "barge activity" is rated quite low in comparison with the environmental categories. Though it reflects a partisan bias, we feel the environmental categories must be considered first in determining areas where fleeting should, or should not, take place. Once those areas are selected, these three categories are considered to be of roughly equal importance in determining what is a desirable fleeting location.
Dredging Frequency	-	See above.
Barge Activity	-	See above.
Water Quality	-	Since water quality is closely linked with significant aquatic habitat and the presence or absence of fish and benthic populations, it is considered one of the more important categories and is ranked highly.
Avian Populations	-	The presence of significant avian populations, including such things as eagle roost areas, heron rookeries, etc. that could be susceptible to fleeting related disturbances, is considered a major category and is rated highly.

ASSIGNMENT OF AVIAN POPULATION FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	WATERFOWL	—	.25	.50	1.0						1.75	.29
B	EAGLES	.75	—	.75	1.0						2.50	.42
C	HERONS	.50	.25	—	1.0						1.75	.29
D												
E												
F												
G												
H												
I												
J	(Dummy)	0	0	0	—						0.00	
									GRAND TOTAL		6.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

ASSIGNMENT OF TERRESTRIAL HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	FORESTED LANDS	—	50	1.0	.25	1.0					2.75	.275
B	OPEN LANDS	50	—	0	25	1.0					2.75	.275
C	DEVELOPED LANDS	0	0	—	0	1.0					1.00	.100
D	WETLANDS	.75	.75	1.0	—	1.0					3.50	.350
E												
F												
G												
H												
I												
J	(Dummy)	0	0	0	0	—					0.00	
										GRAND TOTAL	10.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor have a weight value of 0.0.

ASSIGNMENT OF AQUATIC HABITAT ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES									SUM	FACTOR WEIGHT
A	MAIN CHANNEL	—	0	0	0	.5	1.0				1.50	.10
B	MAIN CHANNEL BORDER	1.0	—	.5	.5	1.0	1.0				4.00	.26
C	BACKWATERS	1.0	.5	—	.5	1.0	1.0				4.00	.27
D	TRIBUTARIES	1.0	.5	.5	—	1.0	1.0				4.00	.27
E	TAILWATERS	.5	0	0	0	—	1.0				1.50	.10
F												
G												
H												
I												
J	(Dummy)	0	0	0	0	0	—				0.00	
										GRAND TOTAL	15.00	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

ASSIGNMENT OF BIOLOGICAL ANALYSIS FACTOR WEIGHTS
BASED ON THE RANKED PAIRWISE COMPARISON TECHNIQUE

	FACTOR	ASSIGNMENT OF IMPORTANCE VALUES								SUM	FACTOR WEIGHT
A	AQUATIC HABITAT	—	.75	10	10	10	50	50	1.0	575	.20
B	SHORELINE TERR. HABITAT	.25	—	10	10	10	50	50	1.0	525	.19
C	DREDGE SPOIL DISCHARGE	0	0	—	50	50	0	0	1.0	200	.07
D	DREDGING FREQUENCY	0	0	50	—	50	0	0	1.0	200	.07
E	BARGE ACTIVITY	0	0	.50	50	—	0	0	1.0	200	.07
F	WATER QUALITY	.50	.50	10	10	10	—	.50	1.0	550	.20
G	AVIAN POPULATIONS	.50	.50	10	10	10	50	—	1.0	550	.20
H											
I											
J	(Dummy)	0	0	0	0	0	0	0	—	000	
									GRAND TOTAL	2800	1.00

Procedure:

1. Compare Factor "A" with Factor "B." Assign a value of 1.0 to that factor perceived to be the more important and assign a value of 0.0 to the least important factor. If the two parameters are believed to have the same relative significance, assign a value of 0.5 to each.
2. Now compare Factor "A" with Factor "C", then "A" with "D" and so on down the list.
3. Then compare Factor "B" with all the other factors (don't compare "B" with Factor "A" - this has already been done).
4. Continue this comparative process with each of the remaining factors.
5. Determine totals for each factor and a grand total for all comparisons.
6. Divide the total score for a given factor by the grand total for that factor's weight.
7. State the major rationale used in assigning the relative importance values.

NOTE: The final comparison with a dummy factor assures that no real factor has a weight value of 0.0.

APPENDIX F

AQUATIC AND SHORELINE TERRESTRIAL HABITAT AREAS

Table F-1. AQUATIC HABITAT AREA
(Hectares)

Segment Number	Main Channel Left Bank	Main Channel Right Bank	Main Channel Border Left Bank	Main Channel Border Right Bank	Backwater Left Bank	Backwater Right Bank	Tributary Left Bank	Tributary Right Bank	Tailwater Left Bank	Tailwater Right Bank	Total Aquatic Area Left Bank	Total Aquatic Area Right Bank
1	103.7	64.2	112.0	15.6	3.7	0	0	4.3	0	0	219.4	84.1
2	69.7	87.6	40.3	36.9	0.9	6.0	0	0.3	0	0	110.9	130.8
3	52.1	70.1	64.2	77.8	0	0	0	0	0	0	116.3	148.1
4	60.5	73.2	87.0	14.4	1.2	0	0	0	0	0	148.7	87.6
5	106.0	37.4	66.8	21.3	10.3	0	0	2.9	0	0	183.1	61.6
6	73.7	29.4	104.0	30.0	5.8	0	0	0	0	0	183.5	59.4
7	33.4	80.6	96.5	16.7	0	0	0	0.6	0	0	129.9	97.9
8	68.3	59.3	57.6	42.6	0	0	0	0	0	0	125.9	101.9
9	32.3	74.6	97.9	19.3	0.6	0	0.6	0	0	0	131.4	93.9
10	75.5	22.8	64.8	61.3	0	0	0	0	0	0	140.3	84.1
11	34.3	64.2	97.9	21.9	0	0	0	0	0	0	132.2	86.1
12	22.8	74.9	143.1	13.2	0	0	0	3.5	0	0	165.9	91.6
13	75.7	50.1	36.3	92.7	0	2.0	0	0	0	0	112.0	144.8
14	64.5	53.0	49.2	63.6	0	0	0	0	0	0	113.7	116.6
15	49.0	51.3	100.8	39.5	0	0	0	0	0	0	149.8	90.8
16	15.6	125.3	166.5	40.0	0	0	0	0	0	0	182.1	165.3
17	105.1	50.7	18.4	53.6	0	1.2	0	0	0	0	123.5	105.5
18	35.1	69.7	257.8	19.0	0	0	0	0	0	0	292.9	88.7
19	43.2	49.2	67.4	56.4	0	0	0	0	0	0	110.6	105.6
20	72.3	69.1	57.9	27.1	0	0	0	0	0	0	130.2	96.2
21	66.5	28.8	25.6	40.6	0	0	0	0	0	0	92.1	69.4
22	53.0	6.3	85.2	68.5	0	0	0	0	0	0	138.2	74.8
23	52.1	20.2	132.2	37.4	0	0	0	0	0	0	184.3	57.6
24	24.2	30.5	292.6	43.8	0	0	0	0	0	0	316.8	74.3
25	22.5	25.9	287.4	78.9	0	0	0	0	0	0	309.8	104.8
26	45.5	3.5	144.0	84.1	0.6	0	0	0	49.0	35.1	239.1	122.7
27	0.6	86.4	85.5	209.7	0	0	0	0	0	0	86.1	296.1
28	50.1	66.2	7.5	71.5	0	14.4	0	0	0	0	57.6	152.1
29	63.4	46.7	22.5	96.2	0	8.1	0.9	20.2	0	0	86.8	171.2
30	73.2	41.5	6.9	100.2	5.8	17.9	0	0	0	0	85.9	159.5
31	77.2	59.9	7.5	19.6	0	32.8	1.2	0	0	0	85.9	112.3
32	57.0	50.7	30.0	32.3	0	0	0	0	8.6	39.2	95.6	122.2
33	58.2	180.3	0.6	135.4	0	2.9	0	0	0	12.7	58.8	331.3
34	134.8	126.7	6.3	95.0	0	67.4	0	0	0	0	141.1	289.1
35	124.4	141.1	91.9	112.0	0	83.8	0	0	0	0	216.3	336.9
36 (Chain of Rocks)	241.9		0		0		0		0		241.9	

Table F-2. SHORELINE TERRESTRIAL HABITAT AREA
(Hectares)

	Forested Lands		Open Lands		Developed Lands		Wetlands		Total Terrestrial Area	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	102.0	34.6	29.4	32.5	0	25.3	0	16.1	131.4	108.0
2	87.8	95.6	15.3	8.6	7.2	0	0	0	110.3	104.2
3	97.9	62.8	12.4	35.7	11.5	0	0	0	121.8	98.5
4	161.9	96.5	10.4	5.5	8.1	13.8	0	0	180.4	115.8
5	86.4	85.2	43.2	8.6	0	0	0	1.7	129.6	95.5
6	78.6	95.6	25.6	0	0	8.1	0.6	3.5	104.8	107.2
7	93.3	61.9	3.5	8.4	0	30.5	4.0	0	100.8	100.8
8	58.2	91.0	65.4	4.9	0	4.3	0	0	123.6	100.2
9	78.3	95.0	6.6	0	0	7.2	0.9	0	85.8	102.2
10	55.6	67.1	38.9	17.2	0	11.8	2.0	0	96.5	96.1
11	87.6	65.7	8.9	31.1	0	3.5	0	0	95.6	100.3
12	75.5	71.4	35.4	8.1	0	21.3	0	0	110.9	110.8
13	46.1	121.8	67.4	1.2	0	14.4	0	0.6	113.5	138.0
14	36.6	59.3	71.4	39.7	6.6	0	0	0	114.6	99.0
15	125.3	31.1	42.9	8.9	5.5	64.2	0	0	173.7	104.2
16	43.8	47.2	61.1	19.9	1.2	35.7	0	0	106.1	102.8
17	23.0	12.7	83.5	1.4	0	97.9	0	0	106.5	112.0
18	27.6	0	78.6	0	0	111.2	0	0	106.2	111.2
19	42.6	0	36.3	0	24.8	115.2	0	0	103.7	115.2
20	14.4	0	0	0	112.6	110.6	0.3	0	127.3	110.6
21	2.9	0	6.9	0	92.4	96.2	0	0	102.2	96.2
22	5.2	0	15.0	0	90.4	101.4	0	0	110.6	101.4
23	45.5	9.8	24.8	0	15.0	94.5	0	0	85.3	104.3
24	184.3	19.6	29.4	13.8	0	83.5	15.0	0	228.7	116.9
25	199.3	27.1	46.7	63.9	0	28.2	8.6	0	254.6	119.2
26	42.6	19.0	74.3	24.2	0	42.6	0.6	5.2	117.5	91.0
27	36.6	33.4	73.2	93.9	0.9	8.6	0	0	110.7	135.9
28	68.0	59.3	13.8	50.1	2.9	0	2.9	23.6	87.6	133.0
29	35.1	30.5	46.7	44.3	12.7	1.7	6.9	20.2	101.4	96.7
30	30.0	41.5	17.2	58.2	70.8	0	1.7	0	119.7	99.7
31	32.3	190.1	9.2	81.2	65.7	0	0	21.9	107.2	293.2
32	24.2	155.5	0.6	76.6	71.4	35.7	0	39.2	96.2	307.0
33	36.9	68.0	0	53.6	72.0	33.4	0	126.7	108.9	281.7
34	87.6	105.4	13.8	44.4	4.6	15.6	0.6	59.3	106.6	224.7
35	70.3	184.0	8.6	18.4	17.0	0	19.9	63.1	115.8	265.5
36 (Chain of Rocks)	68.0		262.7		491.3		4.6		826.6	

APPENDIX G

RAW DATA FOR AVIAN POPULATIONS SUBPARAMETERS

Table G-1. WATERFOWL COUNT

YEAR	NO. OF FLIGHTS	GRAFTON-ALTON	ALTON-ST. LOUIS	ST. LOUIS KIMMSWICK	KIMMSWICK CRYSTAL CITY	CRYSTAL CITY-STE.GENEVIEVE
Dec 73 to Apr 74	5	2,960	N/A	392	286	488
Dec 74 to Jan 75	3	280	N/A	3,141	0	7
Nov 75 to Apr 76	8	10,797	N/A	640	991	1,851
Oct 76 to Apr 77	9	2,050	N/A	873	1,633	3,318
Nov 77 to Apr 78	6	6,363	N/A	391	852	2,602
Oct 78 to Apr 79	8	23,292	N/A	3,084	5,357	17,865
Nov 79 to Apr 80	5	9,637	N/A	865	1,462	8,732
TOTAL	44	55,379	0	9,386	10,581	34,863
River Miles Per Reach		17	22	21	10	25
River Reach Midpoint		211	191	170	154	137
Count Per River Mile		3,258	0	447	1,058	1,359

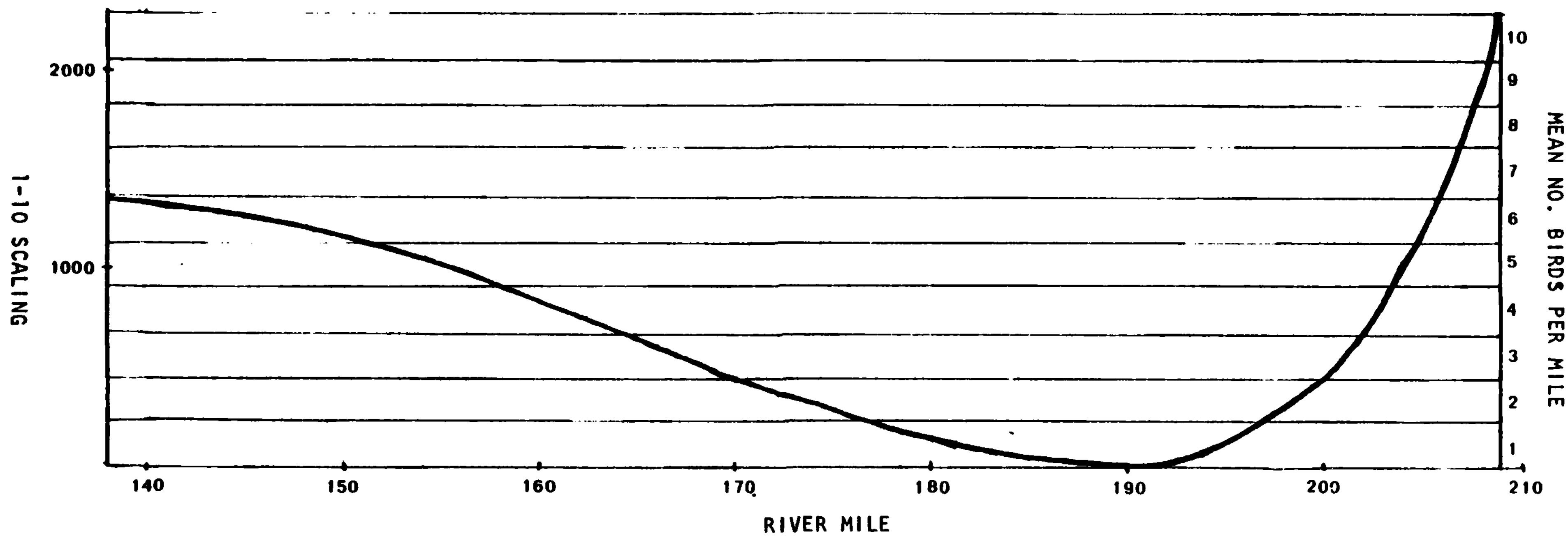

Figure G-1. GRAPH OF AVERAGE NUMBER OF WATERFOWL VERSUS RIVER MILE AND 1-10 SCALED RATINGS

Source: INHS data. See Section 3.3.3 for analytical methods.

Table G-2. EAGLE COUNT

YEAR	NO. OF FLIGHTS	GRAFTON-ALTON	ALTON-ST. LOUIS	ST. LOUIS KIMMSWICK	KIMMSWICK CRYSTAL CITY	CRYSTAL CITY-STE.GENEVIEVE
Dec 73 to Apr 74	5	7	N/A	0	0	2
Dec 74 to Jan 75	3	6	N/A	1	1	0
Nov 75 to Apr 76	8	21	N/A	0	1	6
Oct 76 to Apr 77	9	6	N/A	0	1	4
Nov 77 to Apr 78	6	9	N/A	0	4	5
Oct 78 to Apr 79	8	35	N/A	5	13	24
Nov 79 to Apr 80	5	44	N/A	3	8	10
TOTAL	44	128	0	9	28	51
River Miles Per Reach		17	22	21	10	25
River Reach Midpoint		211	191	170	154	137
Count Per River Mile		7.53	0.0	0.43	2.80	2.04

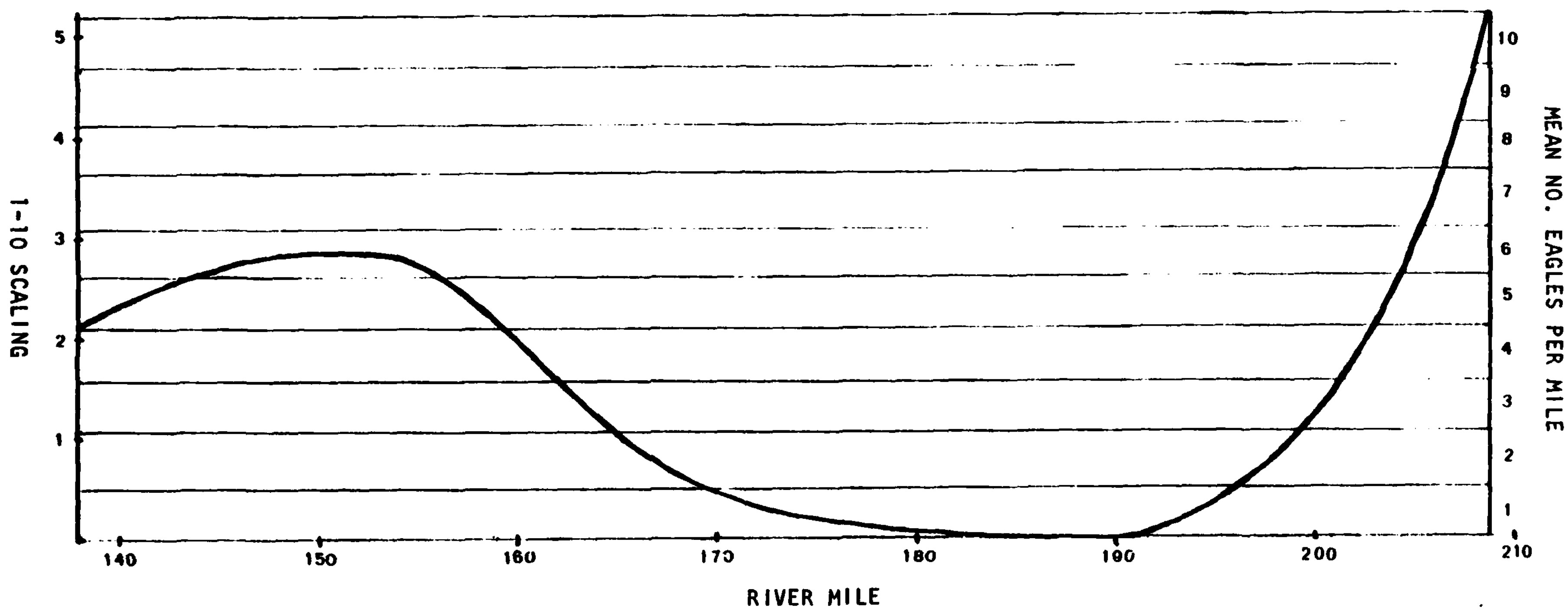

Figure G-2. GRAPH OF AVERAGE NUMBER OF EAGLES VERSUS RIVER MILE AND 1-10 SCALED RATINGS

Source: INHS data. See Section 3.3.3 for analytical methods.

APPENDIX H

RAW DATA

for

DREDGING VOLUME
DREDGING FREQUENCY
BARGE ACTIVITY
WATER QUALITY

Table H-1. DREDGING VOLUME DATA
(April 1970 - March 1980)

Segment Number	Dredging Volume* (100 yd^3) Left Bank	Dredging Volume* (100 yd^3) Right Bank	Aquatic Area (ha) Left Bank	Aquatic Area (ha) Right Bank	Dredged Material Discharge** Left Bank	Dredged Material Discharge** Right Bank
1	5,106	0	219.4	84.1	23.27	0.0
2	0	0	110.9	130.8	0.0	0.0
3	0	0	116.3	148.1	0.0	0.0
4	567	0	148.7	87.6	3.81	0.0
5	0	0	183.1	61.6	0.0	0.0
6	0	0	183.5	59.4	0.0	0.0
7	0	0	129.9	97.9	0.0	0.0
8	0	0	125.9	101.9	0.0	0.0
9	2,078	0	131.4	93.9	15.81	0.0
10	1,617	0	140.3	84.1	11.52	0.0
11	3,925	0	132.2	86.1	29.69	0.0
12	2,311	113	165.9	91.6	13.93	1.23
13	0	0	112.0	144.8	0.0	0.0
14	10,079	3,905	113.7	116.6	88.64	0.0
15	14,113	0	149.8	90.8	94.21	0.0
16	2,236	0	182.1	165.3	12.29	0.0
17	10,661	1,402	123.5	105.5	86.32	0.0
18	559	559	292.9	88.7	1.91	6.30
19	4,735	0	110.6	105.6	42.81	0.0
20	5,326	0	130.2	96.2	40.90	0.0
21	1,493	922	92.1	69.4	16.21	13.28
22	0	16,195	138.2	74.8	0.0	216.51
23	6,108	33,978	184.3	57.6	33.14	589.89
24	3,023	0	316.8	74.3	9.54	0.0
25	0	0	309.8	104.8	0.0	0.0
26	0	0	239.1	122.7	0.0	0.0
27	200	0	86.1	296.1	2.32	0.0
28	0	786	57.6	152.1	0.0	5.17
29	1,720	0	86.8	171.2	19.81	0.0
30	0	0	85.9	159.5	0.0	0.0
31	0	0	85.9	112.3	0.0	0.0
32	1,977	3,862	95.6	122.2	20.68	31.60
33	0	0	58.8	331.3	0.0	0.0
34	0	0	141.1	289.1	0.0	0.0
35	0	0	216.3	336.9	0.0	0.0
36 (Chain of Rocks)	0		241.9		0.0	

*U.S. Army Corps of Engineers, St. Louis District, 2 March 1981.

**Derived by dividing volume dredged by aquatic area for each subsegment.

Table H-2. DREDGING FREQUENCY DATA
(April 1970 - March 1980)

Segment Number	Dredging Frequency*		Aquatic Area (ha)		Dredging Frequency Value**	
	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	3	0	219.4	84.1	0.014	0.0
2	0	0	110.9	130.8	0.0	0.0
3	0	0	116.3	148.1	0.0	0.0
4	1	0	148.7	87.6	0.007	0.0
5	0	0	183.1	61.6	0.0	0.0
6	0	0	183.5	59.4	0.0	0.0
7	0	0	129.9	97.9	0.0	0.0
8	0	0	125.9	101.9	0.0	0.0
9	3	0	131.4	93.9	0.023	0.0
10	1	0	140.3	84.1	0.007	0.0
11	4	0	132.2	86.1	0.030	0.0
12	2	1	165.9	91.6	0.012	0.011
13	0	0	112.0	144.8	0.0	0.0
14	5	3	113.7	116.6	0.044	0.026
15	13	0	149.8	90.8	0.087	0.0
16	2	0	182.1	165.3	0.011	0.0
17	10	2	123.5	105.5	0.081	0.019
18	1	1	292.9	88.7	0.003	0.011
19	3	0	110.6	105.6	0.010	0.0
20	3	0	130.2	96.2	0.023	0.0
21	2	1	92.1	69.4	0.022	0.014
22	0	12	138.2	74.8	0.0	0.160
23	6	24	184.3	57.6	0.032	0.417
24	2	0	316.8	74.3	0.006	0.0
25	0	0	309.8	104.8	0.0	0.0
26	0	0	239.1	122.7	0.0	0.0
27	1	0	86.1	296.1	0.011	0.0
28	0	1	57.6	152.1	0.0	0.006
29	2	0	86.8	171.2	0.023	0.0
30	0	0	85.9	159.5	0.0	0.0
31	0	0	85.9	112.3	0.0	0.0
32	2	5	95.6	122.2	0.020	0.041
33	0	0	58.5	331.3	0.0	0.0
34	0	0	141.1	289.1	0.0	0.0
35	0	0	216.3	336.1	0.0	0.0
36 (Chain of Rocks)	0		241.9		0.0	

*U.S. Army Corps of Engineers, St. Louis District, 2 March 1981.

**Derived by dividing dredging frequency by aquatic area for each subsegment.

Table H-3. BARGE ACTIVITY DATA

	Average Number of Barges*		Aquatic Area (ha)		Barge Activity Value**	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	0.0	2.2	219.4	84.1	0.0	0.026
2	4.8	0.0	110.9	130.8	0.043	0.0
3	0.0	0.0	116.3	148.1	0.0	0.0
4	0.0	1.8	148.7	87.6	0.0	0.020
5	0.0	0.0	183.1	61.6	0.0	0.0
6	0.0	0.8	183.5	59.4	0.0	0.013
7	0.0	0.0	129.9	97.9	0.0	0.0
8	0.4	0.0	125.9	101.9	0.003	0.0
9	0.0	0.0	131.4	93.9	0.0	0.0
10	0.0	2.0	140.3	84.1	0.0	0.024
11	0.0	35.6	132.2	86.1	0.0	0.413
12	0.0	20.0	165.9	91.6	0.0	0.011
13	13.6	0.2	112.0	144.8	0.121	0.001
14	17.4	12.8	113.7	116.6	0.153	0.110
15	7.0	76.2	149.8	90.8	0.047	0.839
16	2.6	2.2	182.1	165.3	0.014	0.013
17	90.2	30.4	123.5	105.5	0.730	0.288
18	29.6	17.8	292.9	88.7	0.101	0.201
19	46.8	71.2	110.6	105.6	0.423	0.674
20	81.6	127.6	130.2	96.2	0.627	1.326
21	28.4	21.8	92.1	69.4	0.308	0.314
22	15.6	5.2	138.2	74.8	0.113	0.069
23	2.0	7.4	184.3	57.6	0.011	0.128
24	0.0	1.6	316.8	74.3	0.0	0.021
25	0.0	0.0	309.8	104.8	0.0	0.0
26	0.0	0.4	239.1	122.7	0.0	0.003
27	0.0	0.0	86.1	296.1	0.0	0.0
28	0.0	0.0	57.6	152.1	0.0	0.0
29	29.4	36.6	86.8	171.2	0.339	0.213
30	65.0	35.8	85.9	159.5	0.757	0.224
31	26.5	36.3	85.9	112.3	0.308	0.328
32	33.5	17.8	95.6	122.2	0.350	0.146
33	18.5	0.0	58.8	331.3	0.315	0.0
34	90.5	24.0	141.1	289.1	0.641	0.083
35	35.0	0.0	216.3	336.9	0.162	0.0
36 (Chain of Rocks)	0.0		241.9		0.0	

*U.S. Army Corps of Engineers, St. Louis District, 2 March 1981.

**Derived by dividing average number of barges by aquatic area for each subsegment.

Table H-4. WATER QUALITY DATA (POINT SOURCES OF POLLUTION)

	Wastewater		Refuse		Aquatic Area (ha)		Water Quality Value*	
Segment Number	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	0	0	0	1	219.4	84.1	0.0	0.012
2	0	0	0	0	110.9	130.8	0.0	0.0
3	0	0	0	0	116.3	148.1	0.0	0.0
4	0	0	0	1	148.7	87.6	0.0	0.012
5	0	0	0	1	183.1	61.6	0.0	0.016
6	0	1	0	2	183.5	59.4	0.0	0.050
7	0	0	0	5	129.9	97.9	0.0	0.051
8	0	0	0	0	125.9	101.9	0.0	0.0
9	0	0	0	1	131.4	93.9	0.0	0.011
10	0	0	0	0	140.3	84.1	0.0	0.0
11	0	0	0	1	132.2	86.1	0.0	0.012
12	0	0	0	0	165.9	91.6	0.0	0.0
13	0	0	0	0	112.0	144.8	0.0	0.0
14	1	0	0	0	113.7	116.6	0.009	0.0
15	0	1	0	1	149.8	90.8	0.0	0.022
16	0	1	0	1	182.1	165.3	0.0	0.012
17	0	5	0	7	123.5	105.5	0.0	0.114
18	0	1	2	0	292.9	88.7	0.007	0.011**
19	0	2	0	2	110.6	105.6	0.0	0.038**
20	2	3	1	3	130.2	96.2	0.023**	0.062**
21	0	0	2	4	92.1	69.4	0.022**	0.058**
22	7	0	2	2	138.2	74.8	0.065	0.027
23	0	1	0	0	184.3	57.6	0.005	0.0
24	0	0	0	0	316.8	74.3	0.0	0.0
25	0	0	0	0	309.8	104.8	0.0	0.048
26	0	0	0	1	239.1	122.7	0.0	0.008
27	1	0	0	1	86.1	296.1	0.012	0.003
28	0	0	0	0	57.6	152.1	0.0	0.0
29	0	0	4	0	86.8	171.2	0.046**	0.0
30	3	0	5	0	85.9	159.5	0.093**	0.0
31	1	0	4	0	85.9	112.3	0.058	0.0
32	3	0	0	1	95.6	122.2	0.031	0.008
33	1	0	2	0	58.8	331.3	0.051	0.0
34	0	0	0	0	141.1	289.1	0.0	0.0
35	1	0	0	0	216.3	336.9	0.005	0.0
36 (Chain of Rocks)	0		0		[illegible]41.9		0.0	

*Derived by summing the point sources for each segment's left and right bank subsegments and dividing by their respective aquatic areas (ha).

**80 percent of 135 harbor spills reported by the U.S. Coast Guard in 1980 originated in these river subsegments. The scale value for these subsegments has been adjusted downward by two scale units.

APPENDIX I

1-10 SCALES

APPENDIX I

1-10 SCALES

SHORELINE TERRESTRIAL HABITAT

Scale	Parameter Value
1	10.00 - 12.09
2	12.10 - 14.18
3	14.18 - 16.27
4	16.28 - 18.36
5	18.37 - 20.45
6	20.44 - 22.54
7	22.55 - 24.63
8	24.64 - 26.72
9	26.73 - 28.81
10	28.82 - 30.90

AQUATIC HABITAT

Scale	Parameter Value
1	8.000 - 9.516
2	9.517 - 11.032
3	11.033 - 12.548
4	12.549 - 14.064
5	14.065 - 15.580
6	15.581 - 17.096
7	17.097 - 18.612
8	18.613 - 20.128
9	20.129 - 21.644
10	21.645 - 23.160

AVIAN POPULATION

Scale	Parameter Value
1	1.00 - 1.62
2	1.63 - 2.25
3	2.26 - 2.88
4	2.89 - 3.51
5	3.52 - 4.14
6	4.15 - 4.77
7	4.78 - 5.40
8	5.41 - 6.03
9	6.04 - 6.66
10	6.67 - 7.30

DREDGING FREQUENCY

Scale	Parameter Value
1	>0.040
2	0.036 - 0.040
3	0.031 - 0.035
4	0.026 - 0.030
5	0.021 - 0.025
6	0.016 - 0.020
7	0.011 - 0.015
8	0.006 - 0.010
9	0.001 - 0.005
10	0.000

DREDGING VOLUME

Scale	Parameter Value
1	>48.00
2	42.10 - 48.00
3	36.10 - 42.00
4	30.10 - 36.00
5	24.10 - 30.00
6	18.10 - 24.00
7	12.10 - 18.00
8	6.10 - 12.00
9	0.10 - 6.00
10	0.00

BARGE ACTIVITY

Scale	Parameter Value
1	>0.80
2	0.71 - 0.80
3	0.61 - 0.70
4	0.51 - 0.60
5	0.41 - 0.50
6	0.31 - 0.40
7	0.21 - 0.30
8	0.11 - 0.20
9	0.01 - 0.10
10	0.00

WATER QUALITY (POINT SOURCES)

Scale	Parameter Value
1	>0.064
2	0.057 - 0.064
3	0.049 - 0.056
4	0.041 - 0.048
5	0.033 - 0.040
6	0.025 - 0.032
7	0.017 - 0.024
8	0.009 - 0.016
9	0.001 - 0.008
10	0.000

BIOLOGICAL SENSITIVITY

Scale	Parameter Value
1	2.59 - 3.27
2	3.28 - 3.95
3	3.96 - 4.63
4	4.64 - 5.31
5	5.32 - 5.99
6	6.00 - 6.67
7	6.68 - 7.35
8	7.36 - 8.03
9	8.04 - 8.71
10	8.72 - 9.39

FILME